FACTORY MANAGEMENT and MAINTENANCE

APRIL, 1933

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Electrical Rehabilitation Pays Us $15,000

With purchased power, new electrical equipment, push-button control, management finds service better, costs reduced $15,000 a year; maintenance has less work by day, none at night

J. G. Coffin

Technical Director
General Baking Company, New York, N. Y.

BREAD, when you make more than 400,000 loaves of it a week—as we do in our Newark plant—means dough mixers, refrigerating units, baking ovens, cooling conveyors. They all take power, which therefore becomes a relatively important item in our manufacturing costs. We found, therefore, that power costs were worth looking into—as they probably are in any plant where they constitute more than a per cent or two of the total cost of the product.

We used to make our own power. Today we buy it. To change, meant replacing all motors and control equipment; the whole plant had to be rewired. That is what we did. It was a big investment, but it has paid.

Power was formerly supplied by two 125-hp. engines driving 220-volt d.c. generators. The equipment was dependable. We took good care of it. It served us well for years. But power and maintenance costs were high.

And that was not all. Engines, generators, and motors were fifteen years old. Judged by present standards, they were becoming more and more inefficient. Maintenance and repair costs were bound to increase. Thence the decision to abandon the power plant. Hence the plan to modernize the entire electrical system.

The work of making the required study of our needs and laying out the new system was intrusted to Peters & Peters, Inc., New York City. We wanted to have the new installation laid out for maximum efficiency, reliability of operation, and safety to operators and equipment. All plans were drawn accordingly.

Installation was complicated by the fact that a shutdown in a baking plant is a serious matter. It was not feasible to close the plant for any extended period; with tons of product going almost continuously through

the various processes, including the baking ovens, it is not possible to stop the operation of any machine for more than a very short time. On the other hand, it was desirable to make the change-over from generated to purchased power as soon as possible after the work had once been started.

These conditions were met by running temporary feeders from the main switchboard to the control room and thence to the various motors. Bases and mountings for the new a.c. motors were prepared in advance so that when we were ready to cut over a machine it was simply a matter of removing the old motor, putting the new one in place, and connecting the leads. Usually a half-hour or so was sufficient for the change.

Of course, new conduit was being installed at the same time that these other changes were being made. As the conduit runs were completed, new conductors were drawn through and permanent connections made as soon as possible. Altogether, a period of several months was required to install permanently all of the new motors and other equipment, but the amount of production time lost in doing it was trifling.

At present we have installed 32, 60-cycle, three-phase, squirrel-cage motors ranging from ¼ to 30 hp., with a total rating of approximately 175 hp. All motors with the exception of the fractional-horsepower sizes are equipped with ball bearings. In addition to these motors we keep thirteen others of various sizes in stock.

Power circuits are fed from a bank of three 75-kva., single-phase transformers in a fireproof vault. These transformers receive energy at 4,100 volts and step it down to 440 volts, the distribution voltage. A bank of three 15-kva., single-phase transformers supplies current at 115 volts to the lighting circuit.

In order to minimize as much as possible the effect of any electrical trouble that may develop, separate circuits for all important motors or groups of motors run to the control room from the main switchboard. Each of the following machines or groups has its own circuits:

1. Main motors on dough-mixing machines.
2. Flour conveyors and tilting motors on dough mixers.
3. Baking ovens and gas machine.
4. Bread conveyors, molding machines, dividers, rounders, proofers.
5. Boiler room.
6. Well pump.
7. Refrigerating units (two).
8. Air compressor.
9. Elevators.

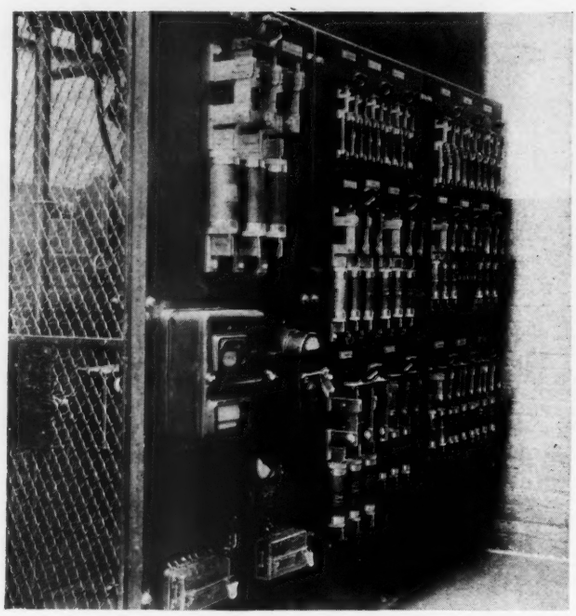
With the exception of a few fractional-horsepower motors which have manually controlled starters, pushbutton control is used throughout. All control equipment is located in a separate room to which only the members of the maintenance department have access. Segregating controls in this way increased the cost of the installation, but we feel it was justified.

One of the important advantages is that the controllers can be kept cleaner than would be possible if they were located near the machines. Also, it is not possible for the machine operators or others to tamper with them. Trouble must be reported to the maintenance department.

Pushbutton control was used with some of the old d.c. motors, and its advantages were so apparent that, except for a few very small motors, it was adopted throughout in the new installation. The operators are not required to use the skill or judgment that would be necessary with manual control; nor can they do any experimenting. As a result, the motors and machines are not subjected to abuse.

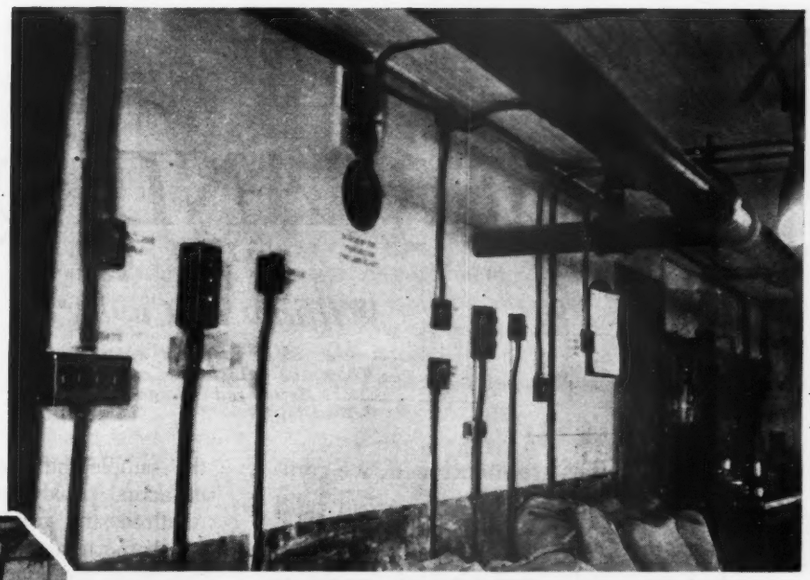
Interlocking of certain controls so that their motors are rendered inoperative under some conditions is an important safety measure that is easy to accomplish with pushbutton control. For example, when a batch of dough has been prepared in one of the mixing machines, the bowl is tilted over on its side so that the dough can be removed. If the agitator were accidentally started while the operator was removing the dough, he would be in grave danger of being injured or killed. To avoid this possibility, the control of the agitator motor is interlocked with the tilting motor control so that when the machine is being unloaded the main or agitator motor can be started only at the will of the operator, who must push a conveniently located button. As a further precaution a relay in the motor circuit permits the agitator arms to make only a few revolutions.

Stopping of the mixing machines is also controlled automatically. While dough is being mixed its temperature must not be allowed to rise above a certain point, which is in the neighborhood of 70 deg. F. Hence a thermostat control is used to stop the agitator motor when the temperature of the dough reaches the desired maximum value. Provision is made for operating without the automatic control; the operator pushes the stop button of the agitator motor control whenever he thinks that the dough has been mixed sufficiently.

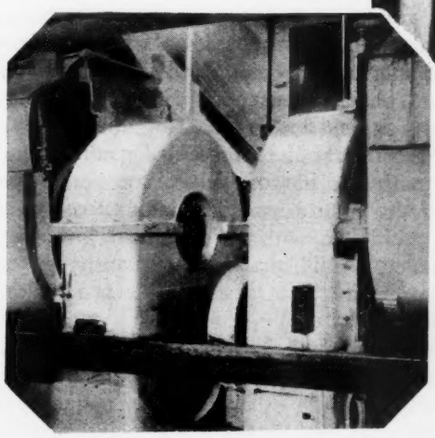


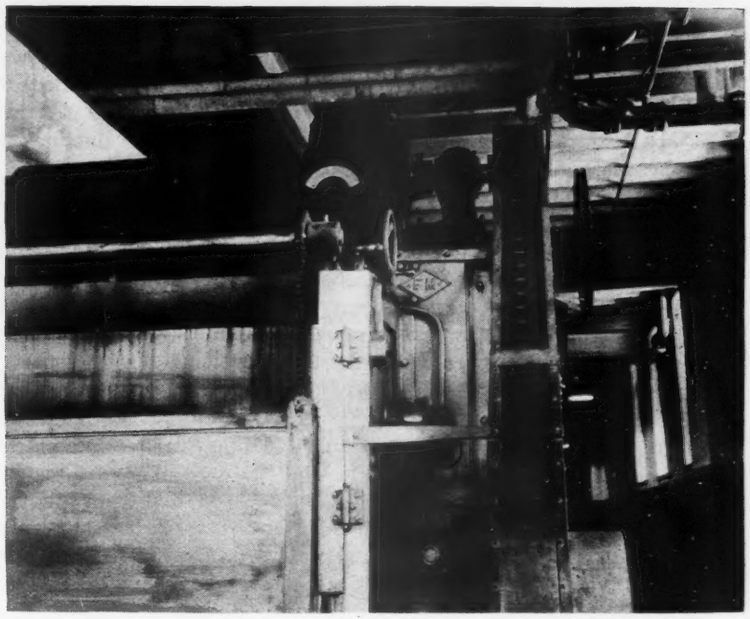
Ten circuits, including a spare line for emergency use, are controlled from this switchboard. All except the emergency circuit go directly to the control room and from there to the individual motors

It has been said previously that interruptions to power



Pushbuttons here, there. and wherever they are most convenient for the operators. The upper view shows control buttons for the dough mixers, placed directly behind the machines. Below, each mixer is equipped with two pushbutton stations, one for the tilting motor, the other for the agitator





A 5-hp. motor is required to move the bread through each baking oven; the ovens are 110 ft. long. By means of a variable-speed transmission, seen at the left of the motor, the speed of travel can be varied over a wide range. The meter in the foreground indicates the speed in minutes required for a loaf to pass through the oven

service are a very serious matter in our plant. In the installation of all of our equipment no precautions were omitted that would increase safety and reliability. As a further safeguard, a separate spare power circuit was run from the switchboard throughout the plant. In the event of trouble with any controller or circuit, long cables, which are kept in the electrical department and have sufficient carrying capacity to handle the maximum load of our largest motors, can be plugged into convenient outlets in the emergency circuit and connected to a motor within a few minutes. Under any emergency affecting the distribution system, short of complete burnout of the transformers and switchboard, any motor can be put back into operation within 20 minutes.

The necessity of maintaining power service at all times is reflected also in our maintenance procedure. Every morning each motor and control is carefully inspected. All machines that are not operating at the time are started up and watched carefully for a few minutes. Needed adjustments or repairs are made at once, and the machine is lubricated, if necessary,. This is true maintenance. Grease lubrication is used on practically all of our equipment, including the motors. When the operators of the various machines come on duty, they are required to run their machines idle for at least two minutes and inspect all parts.

Despite the close attention that is given to all of our equipment, three men now handle the work, whereas formerly six men were required. In addition, purchasing our power instead of generating it has reduced costs about $15,000 a year. This saving will be increased in the future because we have recently taken advantage of the fact that power consumed during the off-peak hours at night carries a lower rate. A meter has been installed, and henceforth power used during the day and at night will be metered separately.

Why Not Incentives for

Quantity *AND* Quality?

William E. Curley

Vice-President
The Thompson & Lichtner Company, Inc.
Boston and Chicago

▸▸ When incentives are mentioned, we commonly think of an extra compensation paid for *additional production.* This is quite natural, because the majority of incentive plans, as ordinarily prepared, have been incentives for increase of production alone

THERE are certain products or processes where the material cost is so high that the difference between the average yield (either in quality or quantity or both) and the best yield has a high money value. Put in another way, if the average yield could be brought up to the best yield, a substantial incentive could be paid the men who had any influence on the yield. The value of the increase in quality, quantity, or both, after paying the incentive to those responsible for such increase, would represent a very worth-while item to the company.

Variations of such an incentive may be applied to various conditions. It may be an out-and-out incentive for quality alone, where the process is such that a slowing-down in production time is not a serious threat. More frequently, however, it is combined with a quantity incentive of some kind.

For example, in the milling of reclaimed rubber, it was found that, whereas a shorter milling time increased the production, it decreased the quality. Consequently, while a series of step standards had been worked out for production in the mill room, it was realized that without some measure of quality a large production bonus might be earned at the expense of quality. On the other hand, quality could be improved by longer working on the mill line. As the product was sold to strict specifications, a higher quality than the standard not only became costly because of added labor and equipment cost, but was also a deviation from the standard the customer was depending on for his products. So a quality incentive alone would not only have resulted in increasing the cost, but would also have carried with it the danger of an irregularity in finished product.

The plan as worked out to fit these particular conditions was to give a sample of the standard quality of the grade being run to the straw boss of the gang, and to establish the ruling that the quality, as tested by the laboratory for each truckload, must be as good as the sample, but need be no better. In fact, although no actual penalty was placed for exceeding the quality required, the result was a decrease in production, on which the total incentive was based. If the quality was not up to the standard, no matter what the production, no bonus was considered earned. So, in reality, each mill-line gang was held in very narrow limits as far as quality was concerned. If the specified quality was not reached, the gang was out of luck, as no bonus would be earned. If the quality was materially exceeded, production was cut down, with a consequent lowering of the bonus earned. This quality and quantity measure resulted, therefore, in the largest possible production of the quality desired.

The example just cited is more in the nature of a *control* of quality than a direct *incentive* for quality.

As an example of the other extreme, a quality and yield incentive plan introduced in a plant producing wallboard is of interest. The process consisted of combining paper and plaster in a continuous machine, the product finally passing through a continuous oven and coming off the end of the line cut into sheets.

The situation under "no incentive" conditions was as follows: On the average 9 to 10 per cent of the finished product was a dead loss, or worse than a loss, for to the cost of the rejected product had to be added the expense of hauling it out to the dump. More than this, it was necessary actually to break it up before hauling, because certain unscrupulous dealers had been found salvaging this material from the dump and selling it to unsuspecting consumers. As it was all marked with the manufacturer's name, the maker had frequent complaints from the purchasers of this waste.

In analyzing the records, it was found that, although the average yield was 90 to 91 per cent, not infrequently a single run, when everything broke just right, gave 97 to 98 per cent of good product. At times, on the other hand, practically an entire run would be rejected.

Usually the defensive explanation of a crew producing such a wide variation in yield is that the whole matter is beyond their control.

Causes of defective product were legion—weight too great or too little, oil spots, under- or over-dried, etc. The feeling was that when the conditions were just right, there was automatically a good yield, and when "things went wrong" conditions were beyond their control and that was all there was about it. The yield would be poor—a kind of fatalistic attitude.

A careful inspection of the process and of the machine indicated that many of the causes of defective product, considered as "acts of God," were to a large extent within the control of the various members of the crew.

After studying the factors involved, an incentive plan was set up, which took into consideration all possible sources of improvement in quality, and paid both for quality of finished product and for speed of producing such quality. A check-back some six months after the incentive was put into effect showed the salable product had risen from an average of 90 to 91 per cent to 97 per cent. As the finished product, whether up to standard, or a dead loss, had had expended on it all material, all drying costs, and all machine costs, this 6 to 7 per cent pick-up, less the cost of the bonus, was a large item of saving.

In this particular product, the material and the mechanical conversion costs were far in excess of the labor cost. Consequently, the amount paid out in incentives for the increased yield was somewhere between 10 and 20 per cent of the entire saving.

The objection may be raised that, since without any incentive the yield of an individual lot had frequently been sufficient to earn a premium under the incentive plan, even if the crew made no effort at all to improve the yield, they would, from time to time, automatically earn a bonus. In this individual instance, the cost of production would be increased without an increase in yield. Such a contingency, of course, had to be anticipated, and the plan had to be safeguarded to prevent just this condition. In the case just described, for example, a week was taken as a unit of time over which to figure the premium. Unless the production over an entire week was in excess of the amount necessary for a bonus, no bonus was earned, regardless of any large individual yields. In another plant, making an entirely different product, where the entire plant personnel participated in the yield incentive, and where the time in process of any lot might cover four weeks or even more, and the yield, therefore, could not be measured until four weeks or more after the lot was started, the yield bonus was figured monthly. Poor-yield lots closed out in any one month automatically pulled down the premium earned on high-yield lots.

►► In this description of quality and yield incentives, details have purposely been omitted. There is no ready-made formula. Each situation calls for special treatment. But, wherever a product shows appreciable waste or low quality between start and finish of the process, a carefully conceived incentive for quantity and quality is apt to result in surprising and gratifying savings

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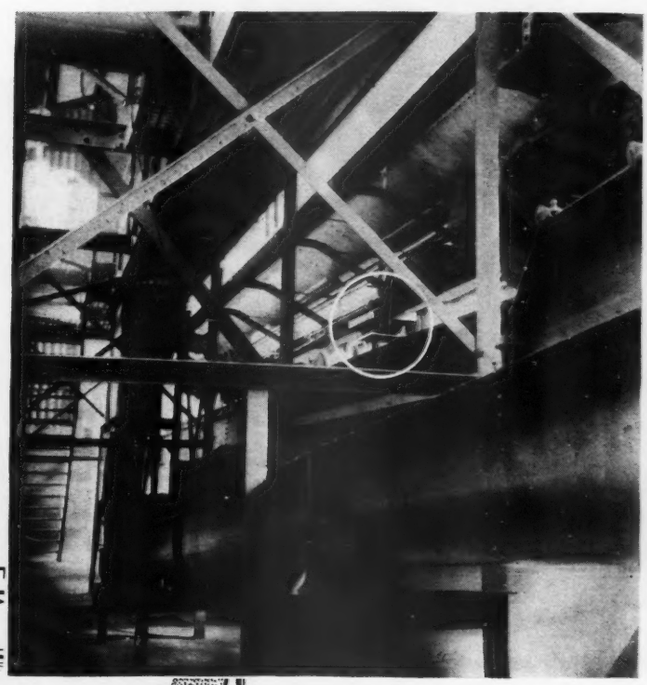
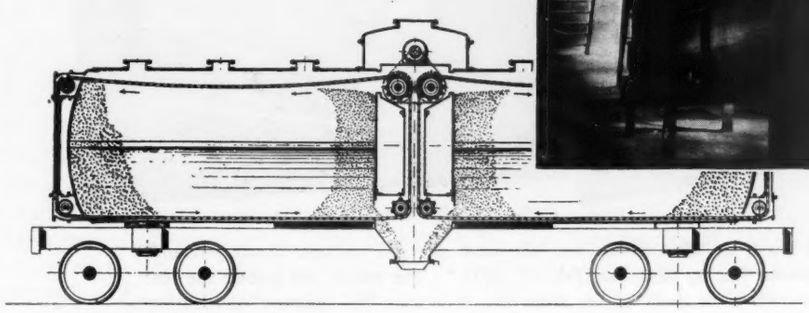
NOT SO DUSTY!



Every time Eternit, Inc., St. Louis, unloaded a car of Portland cement, the plant was flooded with dust. So a car that resembles a tank car has been adopted. Drag chains carry the cement to the circled outlet. It travels via covered conveyor to storage. No shoveling, no dust, no waste. One man starts the job, goes about his business. Machinery unloads a ton a minute. Car handles any dry, dusty material. Flour is one that comes to mind



PRIZE PACKAGES

Seen at the Third Packaging Exposition

Pictured here because packaging is done in the factory by factory men. Good management dictates, therefore, that packages shall be liked not only by those who empty them, but first and foremost by those who fill them

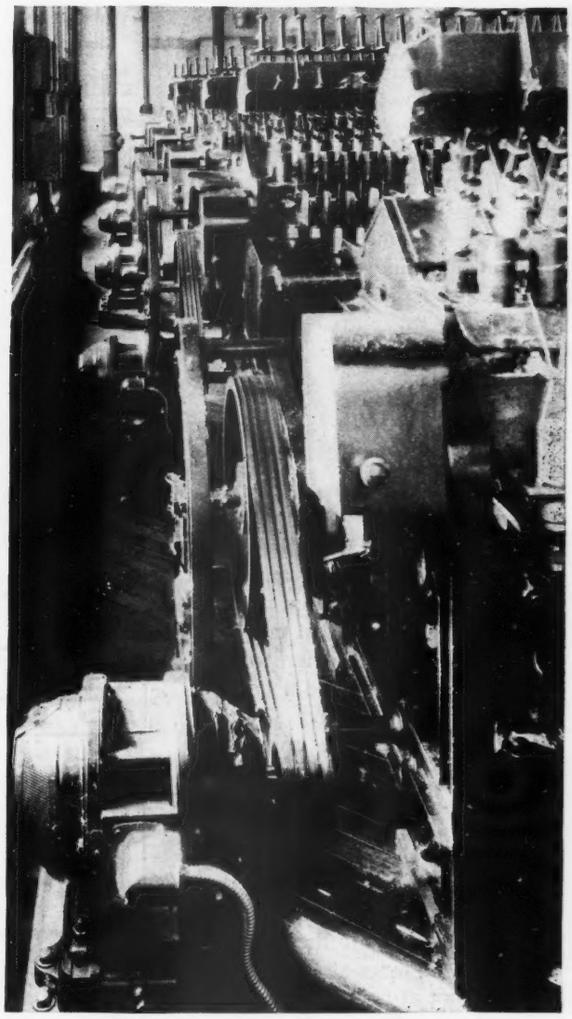
O'Cedar won the second Irwin D. Wolf award for "the most effective package developed and placed on the market between Jan. 1, 1932, and Feb. 15, 1933." The others are among the ten which received honorary awards in their classes from the American Management Association

CHANGED DRIVES . . .

And Stayed in Business

Lewis K. Urquhart
Associate Editor

▶ ▶ Fred M. Foster is like a hundred other plant managers we know. He's "afraid" of electricity. But he wasn't afraid to learn that changing over from an ancient steam-engine drive to a well-considered combination of individual and group drives meant all the difference between staying *in* business and being put *out*



Foster Yarn uses individual motors on spinning and twisting frames. Here a 5-hp. squirrel-cage motor drives a 160-spindle ring twister

"WOULD it be fair to say that with your present combination of group and individual drives you can accept orders which you'd have been obliged to turn down two years ago—and make them at a profit?"

Fred M. Foster, vice-president of Foster Yarn, Inc., Trenton, N. J., thought it over.

"You may say," he replied, "that we wouldn't be in business today, if we hadn't made the change."

A tall statement. Or so at least it will sound to those who have given no ear to the savings often made possible through the installation of modern power drives. It may still sound tall when it is related that the savings, although a substantial part of this company's power bill, amount only to $2,600 a year—surely not enough to keep a concern in business. But the same statement will not sound so tall to those production executives who have become hardened to seeing 50-lb. orders come in from customers who used to buy 500 lb. at a time. Those men will appreciate the advantages that go with the greater manufacturing flexibility which Foster Yarn possesses today—advantages which cannot always be figured in dollars and cents, but are on the annual statement just the same.

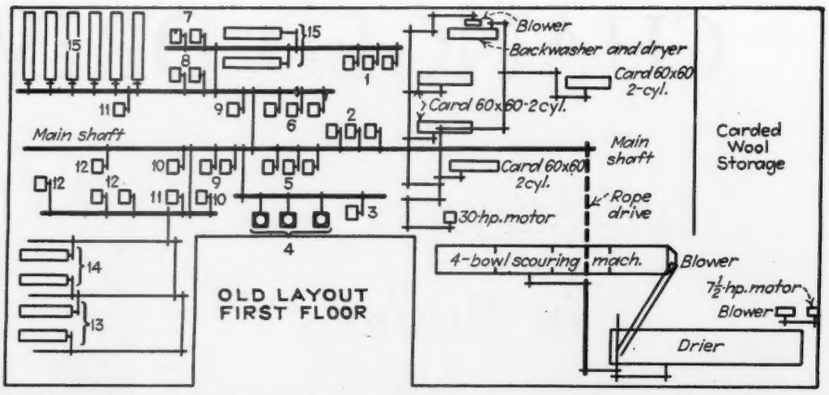
It is increased operating efficiency, then, that has kept this concern in business. Before going any further into that, however, shall we take a quick look at what the company used to have? The old layouts shown on page 128 will help. The main shaft was driven by a Corliss engine. From the main shaft, belts led to the second floor, and through a most complicated and inefficient arrangement through a hole in the wall to the scouring department. Steam was supplied at 115 lb. by a somewhat ancient boiler, which couldn't have kept on much longer, but is quite able to supply steam for present heating purposes. Shaft bearings were not anti-friction type. They had to be lubricated once a week. Maintenance costs were high. Belts were leather, 2-ply, 3½-inch. They had to have a reef taken in them every so often. Slippage—and resulting inability to know drawing, spinning, and twisting speeds—was the biggest drawback. It was nothing on damp days to find variations of 15 to 20 r.p.m., which were translated into discrepancies of 150 to 200 r.p.m. in spindle speeds. Consider that a soft yarn requires a certain rate of speed, whereas a hard yarn needs one correspondingly higher,

and you have some idea of the effect of speed variations on the product itself. You can complete the picture of the old drive's ineffectiveness by adding the fact that it was originally designed to do a much bigger job than it was actually doing.

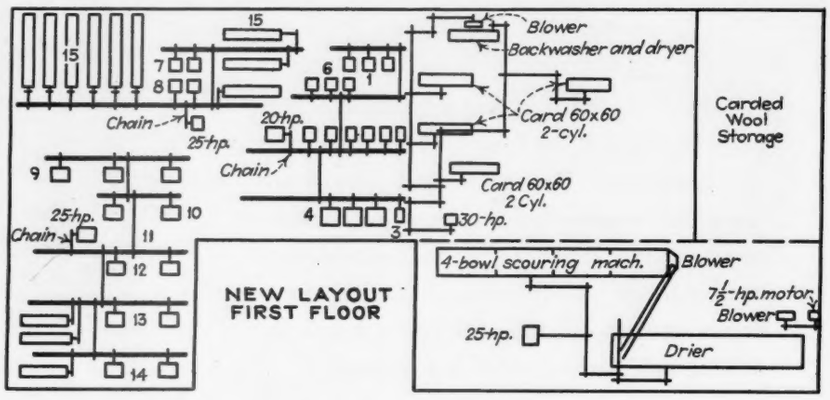
Now for what they have. The new layouts will show that the installation is a well-considered combination of group and individual drives—group where certain types of machinery can be operated economically as a production unit; individual where it is essential to take advantage of the greater flexibility which this type of drive affords. In short, we see Foster Yarn adapting to its own uses the good points of each. Total connected load is about 275 horsepower.

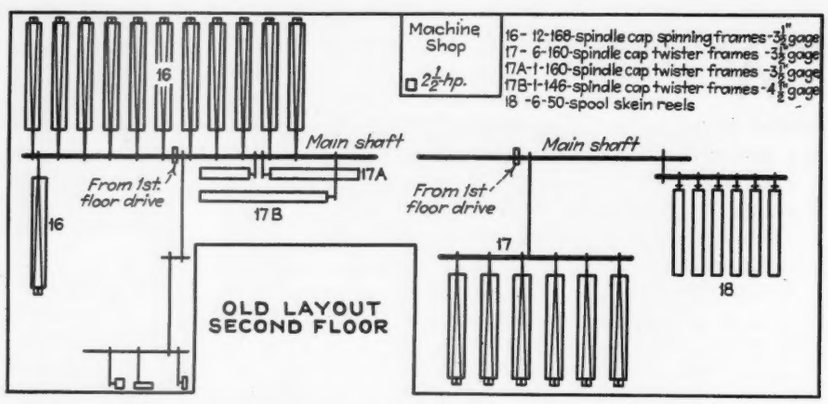
Start with the scouring. A 25-hp. motor operates as a group the scourer, the fan that blows the wool to the drier, and the drier itself. (A 7½-hp. motor operates the blower that conveys the wool from the drier to the cards.) Here we have a typical example of a good group. Scourer and drier are invariably operated at the same time. One operation immediately follows the other. As a matter of fact, almost any change would have been more economical than the wasteful drive that formerly handled this end of the production job. A glance at the old layout will hint at its intricacy.

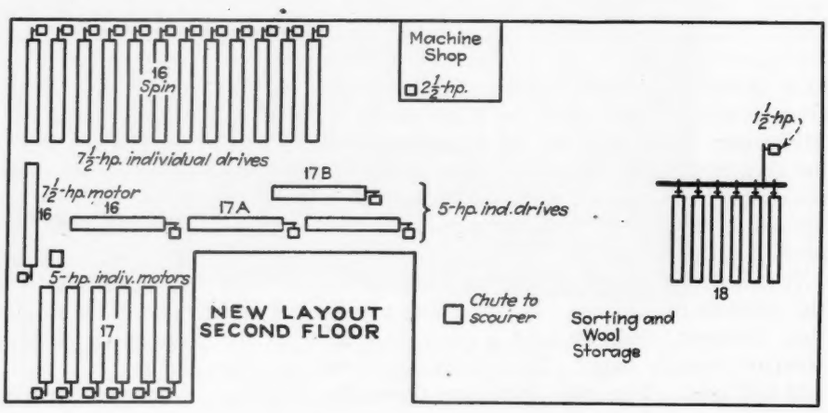
In the carding and drawing rooms it has been found economical to set up four other groups. A 30-hp. motor drives four cards and one back-washer; a 20-hp. motor drives three cones, twelve gill boxes, and a balling machine; a 20-hp. and a 25-hp. motor, between them, drive some 28 drawing frames. Group lineshafts are chain driven. All of the motors are equipped with anti-



1-3-single-head Gill boxes after B.W.
2-3-single-head Gill boxes 2d process
3-1-punch box-balling hand
4-3-Noble Combs double dobber motion
5-3-single-head open Gill boxes-1st process after comb
6-3-single-hd. open Gill boxes, 2d pro. after comb
7-2-double " " " " 3d " " "
8-2 " " " " " 4th " " "
9-3-2-spindle open Gill boxes, 1st pro. draw.
10-2-4 " drawing " 2d " "
11-2-6-spindle drawing (weigh box) 3d. pro. drawing
12-4-10-spindle drawing boxes 4th. pro. drawing
13-2-24-spindle reducers 5th. pro. drawing
14-2-36-spindle reducers 6th. pro. drawing
15-6-36-spindle finishers 6th. pro. drawing
15-2-100-spindle finishers 6th. pro. drawing

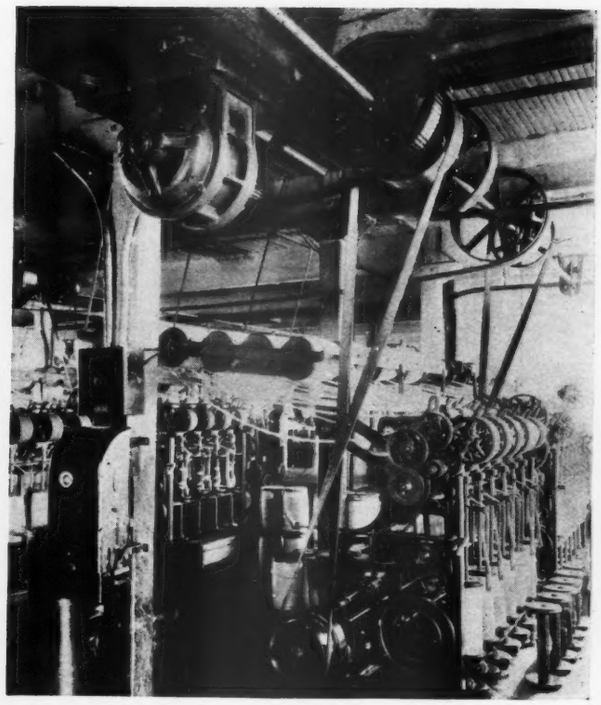






Comparison of old and new layouts will show how group and individual electric drives have replaced the steam engine drive formerly used. Result, a flexibility of operation that has enabled this company to adjust its manufacturing methods to to-day's changing conditions

Group drives are installed wherever a number of machines can be operated as a single unit. Here is a 20-hp. motor driving a group of drawing frames



Every motor is equipped with a jack-type disconnecting switch. Plug in an ammeter and you can check the load without interrupting production

friction bearings. Control is through manually operated compensators.

Spinning and twisting offered a different problem, and the economical solution was found to lie in the selection and installation of individual motors. Thus we see from the figure that thirteen 7½-hp. motors drive as many spinning frames; nine 5-hp. motors drive nine twisters; and one 5-hp. motor operates a sample frame. All of these motors have waste-packed bearings that have needed only three oilings in two years. There is reduced-voltage primary-resistor hand control on the spinning frames, full-voltage pushbutton control on the twisters. There has not been a bit of trouble. One direct result, therefore, is that the foreman of this department has much more time for supervision, can cover a lot more ground than he used to.

A still greater advantage may be found, however, in the ease with which speeds can be changed—an important factor. A frame may be running on 2-ply 20 count yarn. An order for 2-ply 16 count means changing to a lower speed.

Let us see what happened when speeds had to be changed in the days of the old steam-engine drive. First, the whole floor had to be shut down for upwards of half an hour while two maintenance men climbed up on ladders, removed a heavy split pulley maybe 38 in. in diameter, put on another that was equally heavy and hard to handle. The rest of the room could then resume operations, but on the particular frame whose speed was being changed the length of the belt—belts from main shaft to spinning frames were 62-ft. affairs—had to be adjusted. It took another hour for the glue to dry.

Now it is all different. To change speeds, it is only necessary to loosen four nuts, slide the motor forward, slip off the multiple V-belt, knock the pulley off the tapered shaft of the motor, put on the new pulley, move the motor back to get the right tension on the belt, then tighten the four bolts. It takes only five or ten minutes.

To cite a further advantage of the new drive, there is a real increase in production. Formerly they got seven or eight doffs a day—a doff is a complete change of spindles. Now they can count on nine or ten, and can give quicker service on rush orders.

One more feature of the new installation is worthy of comment. Every motor is equipped with a jack-type disconnecting switch, which means power consumption may be checked at any time without interrupting production. All you do is plug in an ammeter and take a reading for each of the three phases of the motor. This provides an immediate check on the amount of current the motor is drawing. The motor will stand an overload, but it all shows up on the power bill. Equally important, an increase in load on a spinning frame is a fair indication that the frame is out of alignment. If that goes on for long, the frame will be down, maybe out.

Has the new equipment paid for itself? If there is still any doubt, disregard the production advantages here set down and go back to the power savings mentioned at the outset. The electric-drive equipment cost $8,000 all told. With a $2,600 saving, it will have just about paid for itself at the end of the third year.

Mice in your Mincemeat? Then hark to the tale of

MIGHTY MOUSERS

". . . However, the engineer ate the candy."

MICE may seem merely humorous to the industrial executive who works exclusively in mouse-proof materials such as metals. But in many factories, more particularly those making food products, the control and extermination of vermin is a major problem. At the same time, to any but incurably solemn plant executives, mice have their funny side.

In one large factory which produces food, mice tend to be a seasonal problem. The plant is situated in a small town, with gardens and fields nearby. During warm weather, mice forage off the countryside and multiply accordingly. When the weather turns nippy, as of one accord they hasten to the food products plant and enter by pathways which remain their own secret. Here they play havoc with raw materials, with semi-finished and finished goods, even gnawing their way into packages through several layers of fiber and cardboard.

For many years the plant paid an exterminator $25 a month the year round to keep down vermin. The exterminator made a monthly visit, fumigated, and poisoned the mice—and plant employees spent a good deal of time until the next visit hunting up decaying mice which showed an unpleasant liking for dying in the most inaccessible spots. It was all very messy, was none too satisfactory, and seemed unnecessarily expensive.

So a year ago last autumn the exterminator's contract was allowed to lapse. Instead, the management bought a large quantity of mousetraps and announced its first annual mouse-trapping contest. Any employee was eligible to enter, and could draw a reasonable stock of traps and cheese. He was assigned a territory in which he might lay his trap lines, and was told to go to it. Prizes were a large box of excellent candy, and a box of not quite so irreproachable cigars.

Most of the entrants were foremen, since they had more time to devote to trapping and also knew more of the geography of the department. None of the female employees could be interested in the competition. For the next 30 days the snapping of mousetraps made a steady hum day and night. When the final returns were in, first prize went to the 250-lb. power plant engineer, who had caught more than 200 mice. His prize was the box of candy, which he preferred to the cigars. All told, more than 500 mice were caught during this month. There was an amount of muttering among the unsuccessful contestants who claimed that the engineer had a triple advantage over them. His traps were in the oldest building on the plant; the boiler room heat drew mice which rightfully belonged to other departments; it was rumored that he made his nightshift firemen tend traps between bouts of shoveling, so that they sometimes caught as many as three mice in one trap during the night. However, the engineer ate the candy.

Ground rules had to be improvised from time to time as feeling ran high. It was determined that a rat counted for five mice, which brought dissatisfaction among those who had no rats in their territories; they claimed, anyhow, that rats are valuable because they catch mice for food, and therefore the rat-catchers interfered with everybody's scores. Another question went all the way to the vice-president in charge of the plant, when one contestant brought in a nest of ten baby mice, newborn, with eyes shut and still devoid of hair. The vice-president ruled in favor of the protestors, and henceforth only fur-bearing mice could be counted. He based his ruling on the high infant mortality prevailing among mice, something which nobody could disprove even though there was some doubt about his facts.

The contest proved that traps are more satisfactory than the professional exterminator's services. So immediately after the contest closed an arrangement was concluded with one of the mightier mousers who had proved his mettle during the competition. He was hired to catch mice and rats in his spare time, using the company traps but supplying his own bait. His previous big-game experience was hunting the Siberian tiger while he served two years as top-kick in the Siberian Expeditionary Force of the United States Army. He gets a nickel per mouse or rat; the extra bonus on rats was removed when it was shown that he really should be willing to catch them for nothing to keep them from killing his mice.

From the management's standpoint the worthwhile fact is that catching mice has cost a flat rate of 5 cents per, instead of the old $300 per year which figured out at approximately 43 cents per mouse.

ARTHUR VAN VLISSINGEN, JR.

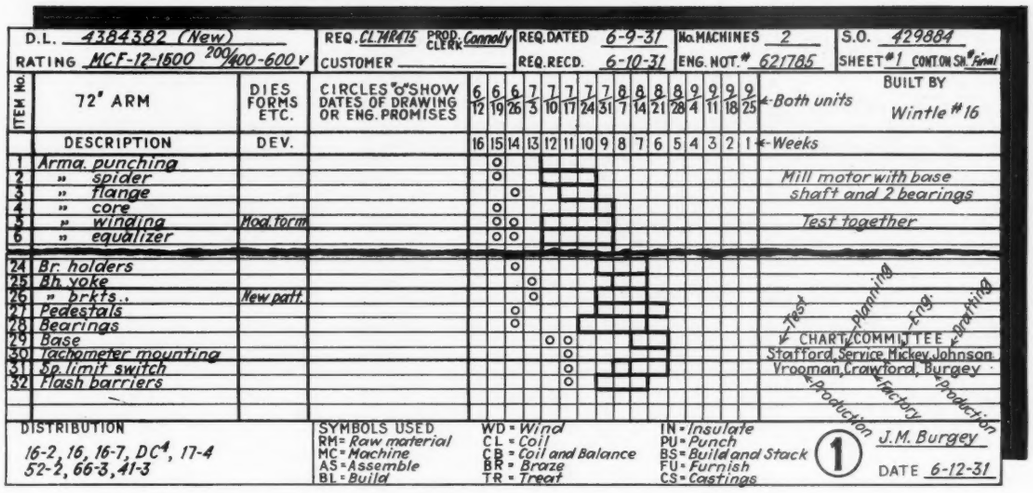


Figure 1. A well-conceived production schedule used in a plant that builds large apparatus to order. It gives all necessary dates, from preparation of drawings to shipping

PRODUCTION CONTROL

4. *PLANNING—Scheduling and Pricing*

Thomas M. Landy

▸▸ There can be no production control without production planning. Landy concludes his description of the planning section's functions with notes on scheduling, routing and pricing, tool and factory planning

IT MUST be remembered that actual scheduling, at least so far as finished dates are concerned, is done in the sales department rather than in the planning office. It is almost a foregone conclusion that the manufacturing organization must accept what the commercial department specifies.

Of course, even under such conditions, a schedule of the various parts must be laid out in order to synchronize their completion, to eliminate large finished and in-process inventories, and to shorten the manufacturing cycle. The production schedule shown in Figure 1 is used to good advantage in a factory that builds large apparatus to order. It supplies the following information: (1) dates drawings and engineering instructions are needed; (2) dates raw materials are required; (3) dates component parts are to be finished; (4) main assembly, testing and shipping dates.

This chart is made as soon as the engineer has issued engineering instructions and the drafting department has made a development sheet, and is the combined analysis of representatives from all functional and manufacturing groups. Each representative agrees to the dates and is charged with seeing that his group is allowed time enough to meet the dates specified. A copy is forwarded to interested foremen, production men, contributing departments, planning department, test department (to arrange for necessary equipment and floor space), and to the production representative in the drafting department.

It is difficult to point to any one of the functions of the planning department and say that it is more important than another. Routing and pricing, however, is certainly one of its primary responsibilities. In the performance of this duty, the planner sets up an operation card (Figure 2) in departments operating under the hectograph method, or a production order (Figure 3) in connection with the mechanical method. Each lists in proper sequence the labor operations, tools, the work station set-up based on the floor layout, changes of gages as well as the prices of all labor operations. It will also show the point value in departments using this form of wage payment.

It is more effective to separate special from routine activities—that is, such activities as methods and motion analysis, alloy-tool applications, department studies, installation of incentive plans, etc. A planner doing routine routing and pricing cannot do justice to these

2702 20m 4-24-31

M.G DEPT. **PLANNING SHEET AND PRICE RECORD** PITTSFIELD WORKS

DR. M- 231929 PT. 2 GR.

MATERIAL DATA

MATERIAL	Brass	PATTERN	
SIZES	½" X 1" X 1¾"		
DEPT. FROM	G.S.		
ACC. POINT	16-P		

APPARATUS D.C.

	DATE	BY	NO. OF SHTS.
DESIGNED			
ROUTED	8/18/31	E.C.	
PRICED	8/18/31	E.C.	SHEET NO. 1

OP NO.	OPERATION	PRICE	PER	SET-UP	SECT	STA. NO.	TOOLS	LOCATION
1	Cut to length	.01	ea		2E	501		
2	Mill comp	.07	ea	1.05	1E	407	31" C.Tte.	7A
3	File radii after mill	.07	ea					
4	Inspect	DW	ea					
5	Tin	.0065	ea					

(2)

Figure 2. Routing and pricing are important functions of the planning section. Here, an operation card used in hectographing factory paper

256-B 20m 7-30-31

PRODUCTION ORDER Date 1/22/32

Shop Order No.	DUE DATES						Quan. on Order
246873	1/25	1/27	2/0	2/7			300

Indicate New Job with an (X)	From	ROUTING					Destination
	X2	1D	3A	4C			Y7

Drawing No.	Name of Part	Division	Device
454057	Contacts	4	H

SPEC. DATA

Finish 264

Signed C.E.B.

DWG. NO. 454057 GR. YEAR. US.
NAME Contacts PT. MIN. ORD. 200 CARD NO.
DEVICE H SUPER NO.

NO.	OPERATION	TOOL NO.	MACHINE #	DEPT.	SET UP EACH	OPER. PRICE
1	Bp	Die 454057	51	1D	.35	1.10M
2	Anneal		57	1D		.24C
3	Fm/comp	Die 454057	59	1D	.80	3.90M
4	Wash		60	3A		DW
5	Checker		64	3A		DW
6	Tin 264		101	4C		.006M

MAT. .060" X 1¾" X 6½" Ext. Spg Phos Bz LBS. PER C 25#
ORDER SIZE:
FINISH: 264 APP'D J.C.K. (3) DATE 1/22/32

Figure 3. A convenient form for routing and pricing when paper is prepared mechanically

activities. It is fundamental, however, that routing and pricing be done by the planner. One plant had a separate incentive department do all pricing, although the operations were routed in a planning department in another part of the plant. This is fundamentally wrong. The man specifying the routing should say how much money is to be spent.

Another mistake made in many plants is in the enormous number of temporary prices. This practice reacts badly both ways. The employees feel that there is no incentive to do well because the price will be changed, and the company must bear the cost of time studies that are unnecessary and non-productive of any good results. Prices should be set fairly and left alone.

The very first thing which is done when modern production planning and control is installed in a plant is to make layouts of each department showing the work stations by number, as well as other helpful data. Tracings of these layouts should be framed and hung in the planning section alongside the planners. Experience has taught that in this way the layouts will be kept up-to-date at all times.

Symbols and abbreviations for machines and operations save much time in the factory payroll and cost department. They are especially necessary in plants using the mechanical method of paper preparation because of the limited space on dupligraph plates.

To clarify the routing and pricing routine now to be described, the following definitions are given:

1. *Standard Operation.* A regularly planned and priced act of processing an item in a definitely stipulated method and in sequence.

2. *Special Operation.* A planned and priced act of processing an item in a stipulated method for the present only, bearing no element of unnecessary labor.

3. *Extra-Work Operation.* A planned and priced act of processing an item in a definitely stipulated method for the present only, but which may be distinctly classed as labor necessary to correct an error.

4. *Set-Up.* That portion of an operation which is used in preparing the work, tools, equipment, etc.

Standard operations are designated by numerals from 1 to 100 and are listed on the planning and cost cards. They may also be designated by a suffixed letter—i.e., 3A—indicating that a necessary operation has been added between operations #3 and #4 for this and all future jobs.

Standard operations should never be changed unless the change is permanent. If changes are made due to changed methods, changed drawings, or engineering instructions which add or deduct work, no symbol is necessary as the planning change slip (Figure 4) will list the reason.

If it becomes necessary to process a standard and priced operation by a day-work operator, the cost must not exceed the standard. When this is done, the foreman must notify the planner who will see that day-work vouchers are obtained bearing a proper rate for the job.

Should the day-work cost exceed the standard price, the foreman must sign the cost card in addition to the time voucher.

Standard operations may or may not include set-up. However, when the set-up is included in the operation, it indicates that it is not practical to differentiate between actual performing and preparing time. Regular set-up should appear as a separate item planned ahead of the operation to which it relates and bearing the same operation number. Any set-up labor must be listed in the set-up space on the cost card.

The extra-cost report shown in Figure 5 is used wherever extra cost is involved. It must be approved by the planner and signed by the foreman. It is then sent to the typist, who prepares the proper vouchers, and stamps "Special" on all copies. Then the form and vouchers are sent to the proper dispatch station. The voucher is given to the operator, and the dispatcher enters the operation on the shop and cost card.

Special operations are entered on the cost card following standard operations, and are designated by numerals from 101 to 200. Thus, special operation ♯104 refers to standard operation ♯4. Special operations must also bear the symbol which explains the reason for the special operation.

The symbols used to designate special work are:

F. New or unsettled methods.

H. Drawing or engineering changes requiring additional work on a specific operation after time for that operation has been sent to payroll, but which on future jobs will be included in original operation.

L. Work ordered complete on contributing or unit-cost departments and received in this section incomplete, making it necessary to perform the operation which should have been done in that department.

N. Repair and return apparatus on which definitely planned and priced operations cannot be predetermined before work is started, but which is necessary in their construction.

Extra-work operations are entered on the last vacant line of the cost card and are designated by the numerals 201 to 300. Thus, extra operation ♯204 refers to standard operation ♯4. Extra-work operations must also bear the symbol which explains the reason for them. The only symbols to be used designating extra work are as follows:

I.R. An inspector's report is necessary on all defective jobs on which the total cost of combined operations within sections or works amounts to $3 or more direct labor.

The following symbols are used for all defective jobs on which the total cost of combined operations within a section or work amounts to less than $3 direct labor:

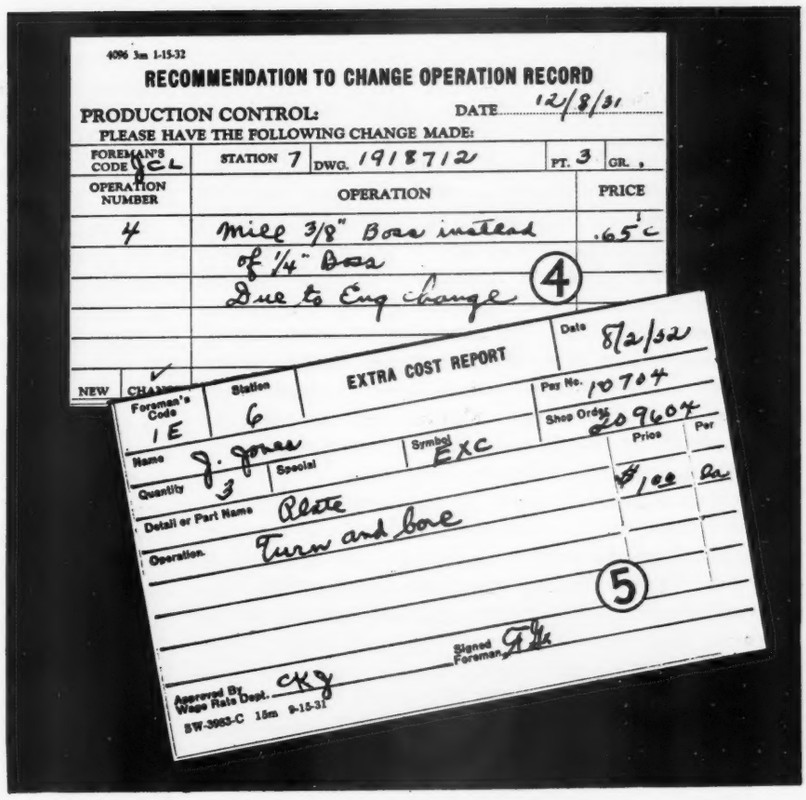


Figure 4. Operations should not be changed unless the change is permanent, and then the foreman who initiates it must get the planner to agree

Figure 5. Report used in one plant whenever an operation involves extra cost. It must be signed by the foreman and approved by the planner

EXA—Equipment troubles.

EXB—Supervision.

EXBB—Planning.

EXC—Defective work.

EXD—Defective material.

EXE—Defects in test (chargeable directly to the testing organization).

EXH—Engineering or drafting changes resulting in additional work required for rehandling the part only for performing the necessary operation.

EXP—Risers or surplus stock over and above normal allowances.

EXPN—Production notice. This symbol is used when extra costs are involved on account of production changes and must be signed by production supervisor or approved by superintendent's office.

EXW—Excess incurred over a standard operation and price by transferring the operation to a day-work operator.

A copy of the daily engineering bulletin must come to the chief planner. He must be notified of all changes. When a change is to be made, the form shown in Figure 4 is made out, usually by the foreman initiating the change. This change card is sent to the planner involved. If both agree to the change, the planner immediately changes his master planning card in ink, initials it, and sends one copy of the change form to the chief dispatcher (to change all current orders) and another to the dupligraph section so that the plate may be changed.

Where two departments overlap on a job, each planning section should have a complete card in its file. For example, in a plant with six decentralized departments having a central screw-machine department which

contained all the Potter & Johnston machines, the routing would look like this:

(1) Bore turn and face	109	SM —
(2) Mill feet	207	K —
(3) Drive	250	K —

Then SM planning section would set up operation #1, and K planning office would establish #2 and #3, all on one card, and each would be given a complete card.

Time studies should be kept to a minimum; much of the pricing can be done by estimating, by comparison, or by charts and data. Fair rates at all times should be the keynote; in this way the planner will have the confidence of the operator while he is protecting the interests of the company. Motion and time studies should be left to people specially assigned to this work and working out of the planning office.

When an inspector's report is necessary, the foreman secures it and lists the operations on the back, signs it, and sends it to the planner involved. He will look it over, price the operations, stamp any not standard, and turn the whole over to the typists, who make a set of vouchers, stamping the vouchers "Special" where necessary. The rest of the routing is exactly the same as that of the extra-cost report.

The inspector's report covers all spoiled work. The extra-cost report covers all spoiled work involving a cost up to and including $3, as well as all special operations which it is not deemed necessary to place on the standard planning card.

It should be the constant effort of planners to keep all indirect expense out of direct labor prices, since under modern production planning and control it should be quite unnecessary to include in the price such allowances as "getting material," "securing blueprint," "securing tools," etc.

The labor-savings report (Figure 6) is made out by the planning section each time a change has been made which will show a saving. By setting up a bogey in advance for each manufacturing department, progress in cost reduction will be noted.

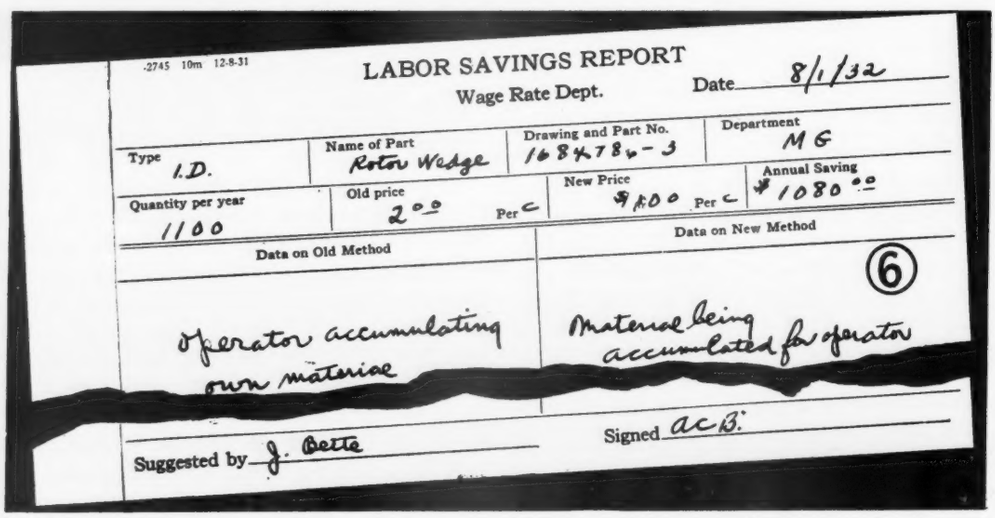
Tool planning is another responsibility of the planning section. Since we are dealing with production planning and control and not with tool design, there will be no attempt here to suggest when and how to make tools. What must be emphasized, however, is the fact that tool planning is, and must at all times be, a part of the general planning section.

In departments engaged in the manufacture of custom-built apparatus, the operation planner, together with the foreman and tool designer, must decide on any tools to be made. Such things as time and money must be considered, as well as the possibilities of further use of the tool on future similar orders.

When we get into stock manufacture, tools become the usual thing rather than the exception. The ordering section should issue a tool write-up listing all parts which go to make up the apparatus. This is turned over to the planner, who checks up on all existing similar planning cards. For the balance of the parts, planning cards must be set up in full, showing all data, such as material, sequence, and operations. It is then that the planner, tool designer, and foreman get together to authorize tools or to decide upon the use of existing tools.

Last on the planning department's list comes factory planning. By this term we mean factory lay-out, disposition of machine tools, placing of conveyors, and even the actual design of new buildings. Just as in tool planning, no attempt will be made here to suggest when a machine tool should be replaced or its location changed, or when a conveyor should or should not be installed, but it should again be emphasized that factory planning must be made a component part of the general planning job. Its activities must of necessity be coordinated with the other planning functions.

▸▸ Next month. Preparation of the individual order, including a description of the mechanical method which involves the use of the familiar addressing machine



.2745 10m 12-8-31

LABOR SAVINGS REPORT

Wage Rate Dept. Date 8/1/32

Type	Name of Part	Drawing and Part No.	Department
I.D.	Rotor Wedge	168478-3	M G

Quantity per year	Old price		New Price		Annual Saving
1100	2.00	Per C	9.00	Per C	$1080.00

Data on Old Method	Data on New Method
Operator accumulating own material	Material being accumulated for operator

6

Suggested by J. Bette Signed A.C.B.

Figure 6. Each time a change is made that will show a saving, the planning section makes a report. One company sets a bogey for each department and gets satisfactory savings

They THINK *and* SAY

On Wage Cuts

WHEN wages were cut a short time ago in Boston's well-known Filene Store, Edward A. Filene, president of the company and long an ardent champion of high wages, was asked how come:

"I am the largest individual stockholder in Wm. Filene's Sons Company," he replied in part; "and would be the person most to be benefited financially if it were true that wage reductions in times like these do benefit a business. But I cannot believe that business can be benefited in any such way. My lifelong study of business convinces me that a policy of high wages is the best and most profitable business policy.

"While I am the largest individual stockholder in the company, I do not control the policies of the company, that control having passed to the Federated Department Stores by an arrangement which I opposed and tried, unsuccessfully, to prevent by legal action.

"I wish it understood, however, that the controversy is purely a business controversy. . . . One group, with no less sincerity than the other, believes that business can best be stabilized and general prosperity restored by wage reductions during periods of depression. The other group, still seemingly in a decided minority, looks upon wage reductions as reduction of the buying power of the masses and the greatest of all causes, therefore, of business depression. It is my contention that business can most effectively economize only by reducing the wastes of production and the still greater wastes of distribution.

"There is plenty of capital in America and plenty of money in our banks; but this money is not now available to business men as capital because the masses, particularly the wage-earners and salaried men and women are so short of buying power that they cannot keep business prosperous.

"I do not speak as a philanthropist or idealist—I simply maintain that any lessening of the consumer's dollar is an injury to business and cannot be of lasting benefit to stockholders. . . . It seems to me that every other plan for business revival has been tried and failed, and that it cannot be long now before business generally will look upon wage reduction as prolonging and intensifying business depression."

Successful Selling Begins in the Factory*

THE REAL producers in an institution such as ours—and I mean specifically by that the factory workers, their supervisors, and development and research engineers—are largely responsible for any high plane of leadership which is attained.

The activities of every worker in our shops and in our engineering and research organization are transmitted directly through the sales organization. Substantial continued confidence in our ability to serve the customer is directly reflected by the way in which all divisions of the organization function.

Let us assume that a demand article is developed, presented to our salesmen, and in turn presented by them to the market.

There is nothing more demoralizing to these men in the "front lines" of the commercial battle than to have a customer complain about goods below the standards he has been taught to expect.

Factory men create these articles, and the salesman bases his solicitation on their serviceability, quality, and appearance, on assurances given him that these products have been made properly by factory workers and put through such rigid inspections that he can confidently recommend their use for certain purposes. We dare not deviate from these standards. It is the production organization upon which the ultimate responsibility of maintaining the uniformity of quality depends.

It is a salesman's job to land the first order with a new customer or a renewal order from an old customer, and the salesman usually feels he has done his part of the job if he succeeds in getting the order on the right basis. *Whether we do any more business with this customer after this first step depends largely upon how workers in the production departments function.*

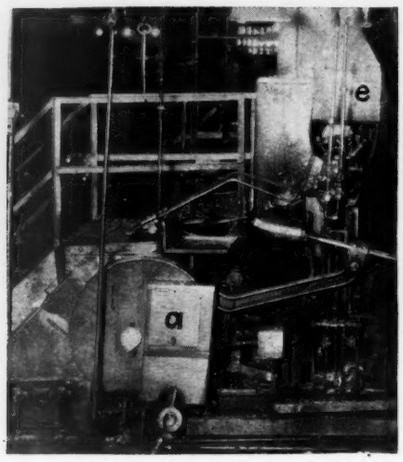
For example, if we: (1) build an article which meets the market demand at a profit; (2) facilitate and expedite deliveries; (3) maintain our established reputation for quality and service; (4) are careful that the articles arrive at their destination in good condition by proper marking and packaging; then workers in the production department have performed a fine service, because the results outlined could not have been possible if the importance of factory cooperation in sales had not been clearly understood throughout the entire organization.

On the other hand, if we: (1) permit defective articles to go to the customer; (2) fail to keep delivery promises; (3) fail to be competitive through waste and extravagance; then the production departments have contributed largely toward destruction of our customers' confidence in us, have been the major factor in wreckage of sales efforts, and are as truly business culprits as an employee who embezzles his employer's funds.

*From an address by Dr. H. E. Fritz, manager, Chemical Sales Division, The B. F. Goodrich Company, Akron, Ohio.

1 Pouring lead pigs. Hoods carry fumes away. Gloves prevent burns—if employees have been taught always to think in terms of safety

2 No fumes. No danger of getting fingers caught in the works. This



A SAFETY TOUR

Safety guards on this picture tour are lettered according to the hazards caused by:

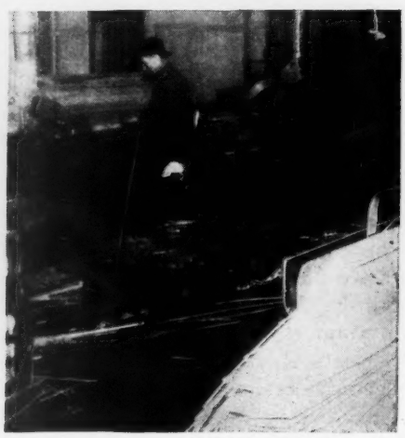
a. Machines	e. Noxious gases
b. Falling objects	f. Dusts
c. Burns	g. Explosions
d. Acids	h. Rough edges
i. Electric shocks	

SAFETY recommendations and practices have been pretty much standardized in the transportation, steel, automotive, packing, paper, and other large industries. Most of them use standard equipment engineered and built by equipment manufacturers. Much of their equipment has safety devices and guards built into it before it is installed. But what of the plant like our own which uses little standard equipment except in its machine shop, toolroom, pattern shop, woodworking department, and power plant?

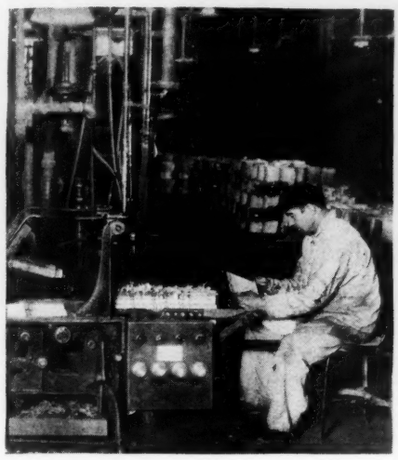
Such a plant must comply with all municipal and state

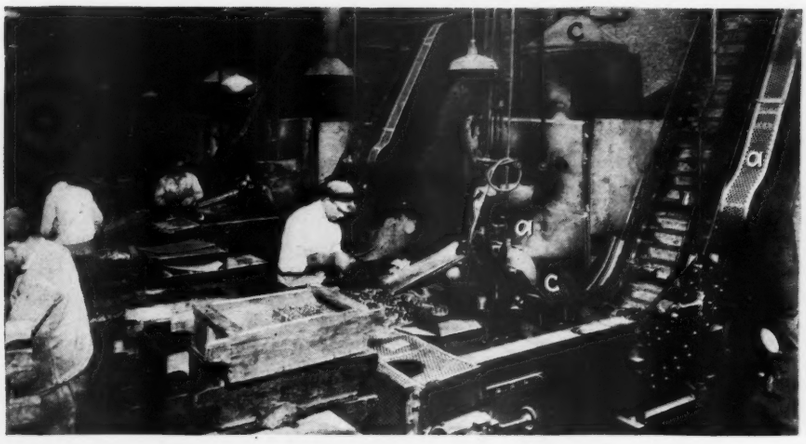
4 When plates are pasted, there is no dust. It is taken away before it gets loose. Toe rail on trestle guards against falling objects

5 Grooving wood separators. Moving parts are protected. Sawdust is ex-



machine that casts storage battery grids is well guarded, safe to operate





3 Here connecting straps are cast. Note the ubiquitous hood. There are guards against burns, guards to lessen danger of accidents to workers

where safety's double sure

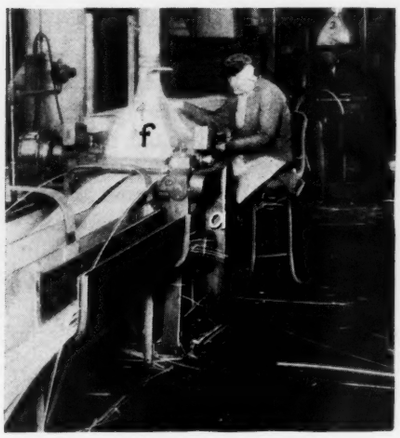
H. W. Lormor
Works Manager
Willard Storage Battery Company
Cleveland

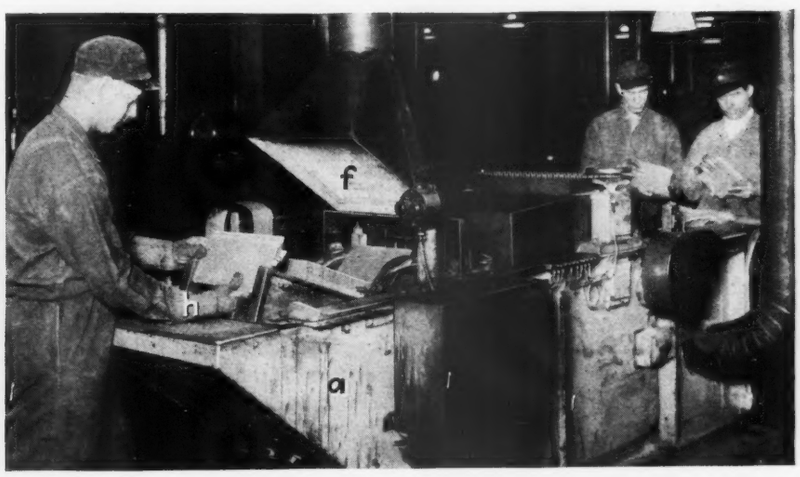
safety rules. For the complete protection of its men and its pocketbook, it must even comply with a few safety rules of its own. It must have machines to manufacture its products quickly and economically in order to meet today's competition and the exacting demands of progress. If it is like most other plants, it begins with hand operations. As volume increases, it develops special machinery to produce more goods with the same labor and space, with uniform quality, and with less scrap. How is it to handle the safety problem? How is it to be sure that lives are not unnecessarily endangered?

The answer in our own plant has been first and foremost to sell the entire organization on safety. We have taught our employees to think in safety terms whether at the machine, in the office, in the locker room, on the street, at home, or at play. Every other move has been secondary to the assurance that our people are truly "safety-minded."

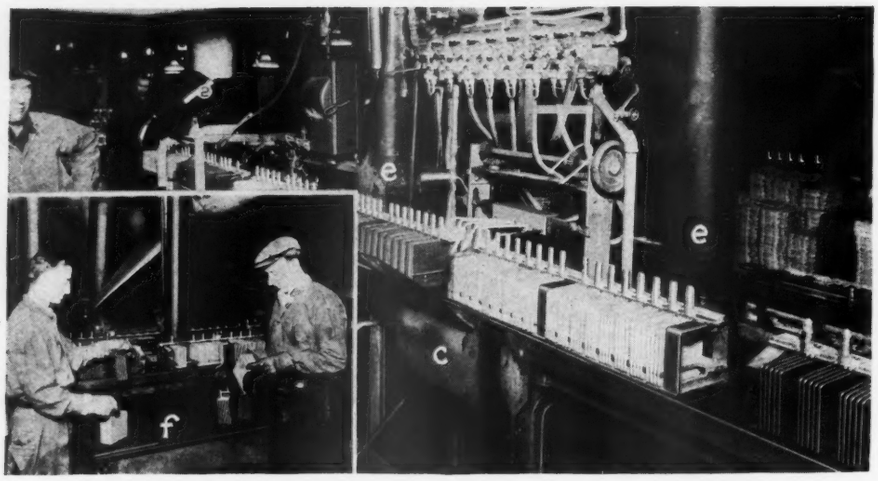
In our experience, if the organization has been sold on safety—there are countless ways of selling them that fall outside the scope of this article—it is easy to build safety into the machinery which it designs and builds

hausted, of course. Better still, the operator has been sold on safety

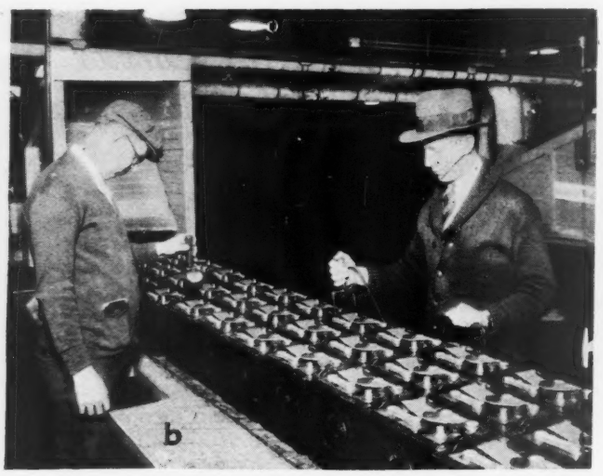




6 Plate edges may be rough. Hence the operator wears gloves. All the moving parts of the machine are completely enclosed. Hood as usual



7 Element-burning machine and plate grouping. No dust, no fumes, no burns. Every precaution against hazards so common in this industry



8 Inspectors working on the assembly line, where side rails prevent batteries from falling off

9 And final testing. Board lessens danger of accident caused by contact with caustic liquids

in its own shops, or whose building it supervises in an outside contract shop. At least, that has been our pleasant experience.

The following principles have governed our procedure in building safety into special equipment:

1 .Change a design on original sketches if another way can be worked out that is less hazardous.

2. Instruct all designing draftsmen to include guards in their designs.

3. In testing a new machine, see that temporary guards are installed before using. These guards include all transmission, belt, gear, and electrical guards. They may have to be altered as the machine is changed during development.

4. When the unit is in perfect shape, install permanent guards before turning the machine over to the production department.

5. Erect penalty notices on machine for tampering with the guard, for removing and not replacing it. Penalize either by suspension or lay-off. Let everyone know when a penalty is imposed.

6. Have daily inspection of guards both by operating department foreman and safety inspector.

7. Do not be backward about making better guards or changes in operation suggested by the operator. He can often save you time and money.

8. When equipment is removed, clear out all old transmission parts, or be sure to guard exposed shafts, pulleys, etc., remaining.

9. Let safety man visit other plants. Have him read current publications and keep up on the subject.

A quick tour of our plant taken through the medium of the nine photographs here shown, illustrates how we have tackled the safety problem, at least that part of it which refers to the safeguard of equipment. An almost complete absence of standard equipment will be noted. It will be seen that each hazard encountered has meant building a special guard in our own shops. On the photographs, incidentally, guards are lettered according to the code in the table on page 136; by referring to it, the reader will find immediate explanation of the hazard that is being guarded against in each instance.

· FACTORY FORUM ·

A new question is presented herewith, and readers' discussions of previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

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How Much Efficiency Now?

The first Spring picnic lunch is over. The wives and helpmeets of George Shipman and Frank Fulleger (works manager and plant engineer respectively) are repacking the lunch kits. Frank's two kids are playing at fishing in a little nearby stream. George and Frank, full of sustenance and satisfaction, are propped against a log some yards removed from the ladies' cleaning and chatter. After sufficient puffs for initial ignition, and trickling the words round the stem of his pipe, Frank ventures to converse.

* * *

"Ought to have more of these outings, George. Great letdown. Fellow certainly needs to relax after a week of going at top speed."

"If I weren't so full, I'd laugh, Frank. Top speed! Haven't you been telling me for weeks how slack you are at the plant?"

"Wait a minute—I didn't say the plant's been going at top speed, I said *I* have. Get the difference? And now you've caused me to wonder why I should. Why can't a whole plant let down when there aren't many orders?"

"Let's see if I get your drift, Frank. Do you mean declare a holiday on improvement? Go along at present efficiency until orders are plentiful, and then begin to figure out short cuts, improve methods, layout, services, and all the rest?"

"Guess that's about what I was trying to say. I hadn't thought it all out—too lazy right now. And I suppose you'll show me I'm wrong, as usual. But look here—what the devil's the use of straining yourself to lop a few seconds off machining time, for example? And with the machine tools of today it *is* a strain."

"I'll answer that one by giving you a few more. What's the use of saving a kilowatt-hour here, or a horsepower there, or some Btu's some place else?"

"I'll bite, George. What *is* the use? By the time the customer gets whatever we're making and he's buying, he couldn't find his share of those savings with a microscope."

"That's one way to look at it—but don't forget —."

"Yo-o-o-o-w!" interrupts a youngster's scream.

"I knew it! Kid No. 1 gets a ducking. To the rescue, efficient parent!" It's Frank's trailing comment as he dashes toward the water.

* * *

Wet kids and calmly talking dads don't go together. We'll have to thresh the thing out without further assistance from George Shipman and Frank Fulleger. Let's do it:

Is the plant justified in letting down when orders are few? Is the individual justified?

Can manufacturing and operating savings continue big enough to demand the same attention given them in the past?

•

ANSWERS TO PREVIOUS QUESTIONS

What Is the Plant Man's Responsibility Toward Sales?

(Question presented in the March issue)

FIRST we should identify this man. He is not the man working at the bench or as a machine operator. He is not the gang boss, who also works under instructions. So we may agree that he is the plant manager, who has a greater freedom of action.

If possible, standard size production orders should be issued to the plant's manufacturing departments to maintain standard costs.

Care should be taken in the selection and purchase of the product materials to get best value at lowest cost.

The engineering staff should be familiar with the plant equipment, its standard and special tools, and their

usages. This department should also have a fairly accurate knowledge of the equipment and production methods which are used by its competitors, and should constantly strive to improve in the manufacture of the product of their own plant.

Another responsibility toward sales is in the employment of well-trained workers who know how to use the equipment and tools in order to produce the maximum volume of high-grade product at a low cost.

Another responsibility is to not burden actual direct labor costs with top-heavy indirect costs. Such unreasonable charges add no value to the product but prohibit the salesman from offering the product to the consumer at honest prices.

Such responsibilities can be met in any plant under competent leadership. When leadership fails to produce salable goods it is not difficult to see that the salesman cannot be blamed if sales dwindle. The plant man alone is responsible.

ROBERT R. CORNELL, *Division Superintendent*
Gorham Company, Providence, R. I.

EVERY plant man from factory manager to shipping clerk has an important relation to sales. Each has a definite place in the manufacturing set-up and all share the responsibility.

War time quality and production methods have gone by the board years back in most plants but it is surprising to see, even at this late date, manufacturing concerns trying to pass on to the consumer frowsy and carelessly made products.

To illustrate: A few days before last Christmas I went down to the sporting goods department of one of the large department stores to purchase a velocipede for the youngster. Selection narrowed to two vehicles of different makes. There was a difference in price of $1. I selected the higher priced one and while the sales clerk was making out the slip, the buyer came along.

The buyer said, "It's funny; that velocipede outsells the other ten to one. Would you mind telling me why you selected it?"

"Well," I said, "from a quality standpoint this one is worth twice as much as the other. Look at that finish. It's a one coat job and so thin you can see the metal through it. They skimped on the nickel and after a rain or two rust will show up. But that isn't all. See that main bearing. It's crude; cost more to make and will get out of whack after a bump or two. Now let's look at the vehicle I bought. It's clean cut of design. It's well made and looks it. But the manufacturers didn't stop there. They put a good job of enamel on it; used plenty of nickel; and that main bearing is simple in design and can't get out of whack. This product will be running around long after that one would be in the rubbish pile."

Now let's see what happened in the plant making the inferior product. By skimping here and there on finish and retaining an obsolete bearing design they managed to save forty or fifty cents in cost. Yet actually they lost dollars in sales. Instead of getting half the business they got one-tenth. You can't stay in business with that batting average in sales. In fact the buyer told me he had decided to discontinue the item.

Let's pin down responsibility. Of course the general manager and factory manager were primarily responsible but if the key plant men had been on the job they might have corrected the situation. Apparently no one seemed to think he was responsible.

The purchasing agent lost sight of quality in paint by buying price. The engineering department was lax in retaining an obsolete bearing design. The plating department fell down on the job by skimping on nickel. The finishing department lost sight of the fact that a cheaper enamel or paint requires more coats to cover. The inspection department should have rejected the whole job.

It seems to me that the "plant man" has a serious responsibility toward sales.

J. M. MURPHY, *Industrial Engineer*
Lakewood, Ohio.

THE PLANT man has the primary responsibility toward sales. To him more than to anyone else must management look for increased sales.

The engineering department lays out the product; it is manufactured and sold. Each department has its function; each is responsible for the success of the product, but the factory man has the greatest responsibility.

The product must be made right; it must have strength, beauty, color, must be made on schedule and reach the customer when he wants it. But more important than anything else is the matter of cost.

Selling prices have been reduced. It is true that material costs are somewhat less, that labor costs have been reduced somewhat, but all these savings are usually less than the difference in selling price compared to several years ago.

It is up to the plant man to effect the economies needed to put the article out at a price that will enable the company to make a little money. It is not always possible to get new machinery or equipment, but it is possible to get new and better ideas out of trade journals from such articles, for example, as the one on money saving controls in the March issue of this magazine.

There is no excuse for any plant man failing to keep up with the newest things in the field. The proper exercise of ingenuity, the cooperation of the other men in the plant, and the information he gets from others should enable him to turn out his product at a price that is right.

E. F. WERNER, *Superintendent*
American Fixture & Showcase Mfg. Co.
St. Louis, Mo.

SALES responsibility is too often divorced from profit responsibility. The plant man is paid for manufacturing the best product possible and for manufacturing it at as little expense as possible. He is not only paid for those services, but is interested in doing his job in the best way possible and, moreover, he is vitally interested in knowing that his efforts are reflected directly in sales and in profits.

The responsibility of the plant man consists in the translation of his knowledge of product quality and production economy into sales information and profit possibilities.

The skill and hard work of the plant man has been

used in one of two ways. In the first case, the improvements in quality have been used by the sales department as points of competitive sales advantage. Decreases in cost have been too often the apparent justification for decreased prices. The sales department, taking advantage of a quality feature or a decrease in costs, recommends price decreases to increase volume. The further decreases in costs due to increased volume, if it materializes, are again used as a justification for lower prices. This circle of improved quality, decreased costs, decreased prices, increased volume, and further decreased costs and decreased prices, may result in sales but it very seldom results in profit.

In the second case, a more rational sequence of quality, cost, and volume changes may take place. The early history of the automobile manufacturers was a notable example. Quality improvements were reflected in higher prices. Economies in cost were a direct addition to profit. Profits were used in research and development for direct improvements in quality and economies of production. Because it costs money to devise ways and means to improve quality and decrease costs, it is necessary to establish both sales and profits before the maximum effectiveness of such efforts can be realized.

The plant man's responsibility toward sales is based on his knowledge of the quality and cost of his product. It is his responsibility to convince the sales department that sales alone do not justify decreased prices.

A part of profits, secured from the right prices, must be spent in the development of cost reduction methods before prices are decreased.

The connection between the plant man and the sales department should not be a form of absent treatment. The plant man must cease to be hypnotized by his own sales representative into believing the pure fallacies that price reduction and economy in costs are the whole object of sales. Profit must be considered.

P. H. LITTLEFIELD, *Service Department*
The John B. Hall Corporation
New York, N. Y.

Can the Stripping of Idle Machines Be Justified?

(Question presented in the November issue)

STRIPPING machines and equipment of either parts or material is justifiable under certain conditions, for example:

(1) In all progressive plants there is always some equipment actually obsolete or rapidly becoming so. Where a number of units are involved in this category, a point is reached where carrying or buying spare parts is not justified. To compensate for original capital expenditure and depreciation set up such equipment must be kept running either for a definite time or until its replacement becomes a reality. Here then, especially in a time of depression or slump, when the production end can be satisfactorily met, it is obviously in order to salvage parts from one machine for use on another.

(2) Certain materials will deteriorate when left idle for any extended time. My attention was called to leather belting on machines, about $1,000 worth; it was stripped off, stored, and requisitioned out in place of new belting. Had this belting been left in place for a couple of years it would have been worthless when starting up again.

(3) Without intensive production, the present affords ideal opportunities for experimenting with equipment and parts in connection with development. With only limited funds available, this work makes stripping necessary at times.

(4) The necessity to carry excessive overhead, in order to keep equipment intact, may also warrant stripping.

The foregoing have been classed as "justifiable stripping" instances. Nevertheless, the practice should be closely controlled and absolutely condemned when applied to standard length of time. If not controlled, there is lack of protection against production orders—especially those of a rush nature, so much in demand these days. Uncontrolled stripping usually means rush maintenance work to get the equipment back in shape and the cost of such work is always maximum. The work itself often is make-shift or slip-shod.

Today one of the vital issues is that of keeping accurate costs and where equipment is continually being haphazardly robbed of parts it becomes a difficult matter to properly keep such costs and credits without spending more in doing so than apparent savings accomplish. Another item of no small measure is that of the accident and safety hazard presenting itself when starting up again—where it has been forgotten or the fact overlooked that vital parts had been removed.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company, Niagara Falls, N. Y.

Should Maintenance Be Consulted in the Design of Special Machines?

(Question presented in the January issue)

BY ALL means the maintenance engineer should be consulted in the design of special machines. The designing engineer seldom comes in close contact with actual production. His views are from the sidelines, and in many cases he designs a machine that is not what is actually wanted.

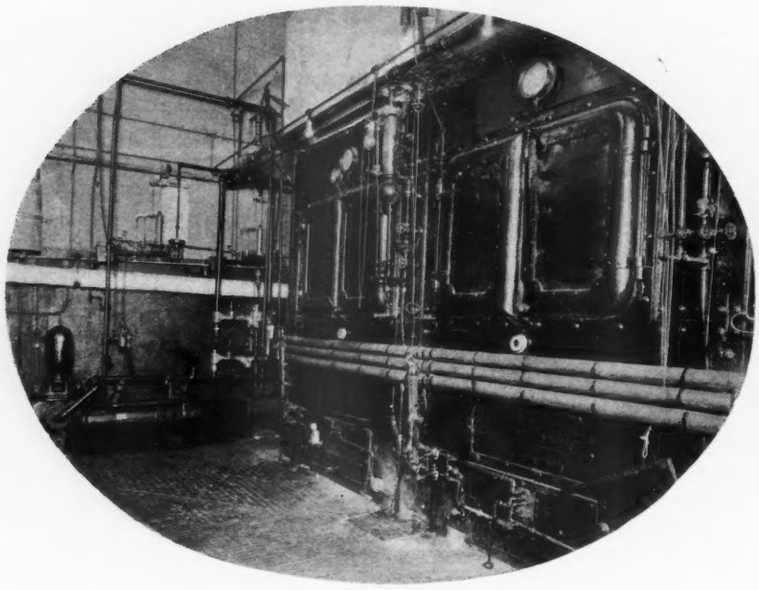
The maintenance engineer is in close contact with the production foreman and between them they work out many minor details that increase production and improve the quality of the article manufactured.

Simplicity of controls, accessibility and ease of operation for the machine operators tend to reduce maintenance costs.

If the maintenance department is consulted and its suggestions are incorporated in the design, the maintenance personnel feel the machine is a part of their own creation and put forth a stronger effort in the installation, connecting up, and starting up of the new machine, items which govern maintenance costs of special machinery.

HARRY H. PANNING, *Mechanical Superintendent*
Weyerhaeuser Timber Company
Klamath Falls, Oregon

For lower steam costs—



Oil did what coal couldn't: gave increased steaming capacity, cut fuel costs 33 per cent

COAL *or* OIL?

David Moffat Myers

Consulting Engineer, New York, N. Y.

Discussed from the background of more than 25 years of experience in power plant design. The author has served as consultant to many well-known companies

IF EVERY owner or manager of a manufacturing plant were able to answer correctly for his own case the question, "Is oil or coal cheaper?" the reduction in operating costs in our industries would be many thousands of dollars a year. For the individual plant the change from one fuel to the other would frequently change the book balance from red to black.

For example, this morning's mail brought a letter from a manufacturing client in New Jersey stating, "Our savings in fuel costs amounting to some 33⅓ per cent are somewhat better than expectations. Our capital outlay was considerably less than we had first anticipated." Here, briefly, is the rehabilitation story of that plant's combustion equipment:

Three horizontal tubular boilers, old but still good for the required service. Hand-firing with bituminous coal and natural draft showed the usual low efficiency under these conditions, and a fuel cost per thousand pounds of steam of about 35.7 cents. Under load demands there was continual complaint, due to insufficient steam for manufacturing and building heating.

A survey of the plant showed that with efficient combustion the boilers would have ample capacity to carry the load. The study, which included consideration of all available systems, indicated oil burning as the most economical solution from the standpoints of reduced cost of steam generation, flexibility, and steaming capacity. And the fuel cost of steam should be about 23 cents, instead of 35.7 cents.

Plans and uniform specifications were prepared covering the type of equipment best suited to this installation, including such essential considerations as type of boilers, settings, operating force, and character of steam load. Selection of the successful bidder on these uniform specifications insured not only purchasing at the right price but, more important, securing the type of installation best suited to the conditions.

After an operating period to correct all adjustments the final official test was made to determine fulfillment of the guarantees.

The saving in fuel gave a 63½ per cent return on the investment, which will repay the capital outlay in 1 year and 7 months. In addition, formerly incessant complaints about insufficient steam have been eliminated.

Does this story mean that all plants can do likewise? No. I can tell you stories of changes to oil which are as sad as this one is cheerful. Nevertheless, hundreds of plants, if properly analyzed and engineered, could substitute oil for coal with savings of one-third, or more, of their present annual fuel cost. In a good proportion of them the entire investment could be liquidated by the savings of two years' operation. I am not figuring years like 1929, but years like 1932 and 1933. The savings will increase as plant production grows.

Coal is down in price, as far as it will ever go, I trust; much is sold at the mines at considerably less than the cost of production. General opinion on the oil situation would indicate that oil is likely to remain at approximately present prices for some years.

Unfortunately, much misleading information on the comparative value of coal and oil exists. Statements may be made in good faith by those who promote the sale of oil or oil-burning equipment. The trouble and confusion come through lack of ability on the part of the sales prospect to interpret such information correctly.

For example, a common statement is that 3 bbl. (or 126 gal.) of fuel oil is equal to 1 ton of coal. The prospect may conclude that if he can buy 3 bbl. of oil for the price of a ton of coal, he will break even on the fuel cost of making steam. This conclusion may be wrong.

This 3-bbl. equivalent is based upon the assumption that when the plant adopts oil it will increase greatly the thermal efficiency of the boilers. If the boilers are already operating at high efficiency, however, shifting to oil would cause a heavy loss on annual cost of fuel.

The true heat content of fuel oil versus coal as purchased is on the order of nearly 4½ bbl., not 3 bbl., of oil to 1 ton of good coal. If the boiler efficiency remains the same, 4½ bbl. of oil will be required, and the fuel cost of steam will be 50 per cent higher than predicted.

Advantages which can often be secured with oil are: (1) Greater flexibility of steam production to meet irregular and sudden demands; (2) full steaming capacity so that fewer boilers need be operated; (3) better control of combustion efficiency; (4) reduced banking and stand-by losses; (5) elimination of dust from coal and ashes; (6) better working conditions for operatives.

The first question to be settled is whether a change from coal to oil would reduce the fuel bill. If that is determined in the affirmative, the important considerations of safety, efficiency, design, and adaptability must be handled skilfully.

Many years ago, I derived a very simple rule-of-thumb that shows quickly which fuel offers more heating value per dollar. It is: Fuel oil at x cents per gallon equals good bituminous coal at $2x$ dollars per 2,000 lb. Thus:

1. Fuel oil at 2c per gal. = good coal at $4 per 2000 lb.
2. Fuel oil at 2½c per gal. = good coal at $5 per 2000 lb.
3. Fuel oil at 3c per gal. = good coal at $6 per 2000 lb.

Simply double the price per gallon of oil, change the cents to dollars, and you have the price of a ton of good bituminous coal, which will put in your bunker the same B.t.u. per dollar as will oil at the given price per gallon.

Take case No. 2 above, where 2½c. oil is equal to $5 coal. If coal costs $6 instead of $5, the bunker is being filled with stored heat units costing one-fifth more than oil for the same actual heat value. Hence, a change to oil should be studied.

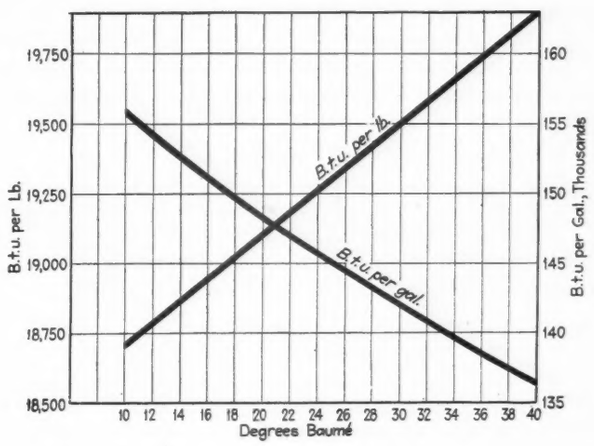


Figure 1 — Heavy oil contains fewer heat units to the pound, but more to the gallon, and costs less

Table I—COST OF EVAPORATION WITH VARIOUS FUELS

Fuel	Price per unit	B.t.u. per lb.	Efficiency of boiler and furnace	Net evaporation from and at 212° per lb. or cu.ft.	Fuel cost to evaporate 1,000 lb. steam from and at 212 deg. F.
1—Bituminous	$4.00 per 2,000 lb.	14,000	Hand-fired 63%	9.10	$0.22
2—Bituminous	$5.00 per 2,000 lb.	14,000	Hand-fired 63%	9.10	0.275
3—Bituminous	$4.00 per 2,000 lb.	14,000	Modern Stoker 73%	10.55	0.19
4—Bituminous	$5.00 per 2,000 lb.	14,000	Modern Stoker 73%	10.55	0.238
5—Small Anthracite	$2.00 per 2,000 lb.	12,000	Hand-fired 60%	7.43	0.135
6—Fuel Oil	$0.05 per gal. (7½ lb. per gal.)	18,500	73% Oil-burners	per cu. ft. 13.92	0.478
7—Fuel Oil	$0.04 per gal.	18,500	73% Oil-burners	13.92	0.382
8—Fuel Oil	$0.03 per gal.	18,500	73% Oil-burners	13.92	0.287
9—Fuel Oil	$0.02 per gal.	18,500	73% Oil-burners	13.92	0.191
10—Natural Gas	$0.30 per 1,000 cu.ft.	1,000 B.t.u. per cu.ft.	73% Gas-burners	0.753	0.398

With oil at 2.33c. and bituminous coal at $4.66, there is an even break as far as purchase price goes. But if the efficiency with coal is 40 per cent and can with oil firing be increased to 72 per cent, there will be a saving of

$$\frac{72-40}{72} = 44.4 \text{ per cent.}$$

Hundreds of medium- and small-sized plants are running at annual efficiencies of 40 per cent. Consequently, with oil at even prices with coal a suitable, properly operated oil-burning system will save 44.4 per cent of the annual expenses for fuel.

In applying the rule-of-thumb to anthracite steam coals, the latter should be rated at 85 per cent of the calorific value of equal grades of bituminous. For example, application of the rule to 2½c. oil and $5 anthracite would be:

$$2\tfrac{1}{2}\text{c. oil} = \$5 \times 85\% = \$4.25 \text{ per } 2{,}000 \text{ lb.}$$

The cost per thousand pounds of steam for various fuels and efficiencies is shown in the table.* The efficiencies noted may be either considerably higher or lower, depending upon the design, operation, and load factor of the plant.

To determine the possibilities of oil burning in a given case, first determine the fuel cost of 1,000 lb. of steam and the efficiency under present operation; then compare reasonable figures of what this cost would be with oil under existing plant conditions, oil prices, and load factor.

The fuel cost with coal will be:

$$\frac{1{,}000 \times \text{coal cost per } 2{,}000 \text{ lb.}}{\text{Evap. per lb. of coal} \times 2{,}000} = \text{Fuel cost, 1,000 lb. steam}$$

Thus, if 7 lb. of steam are obtained per pound of coal costing $5 delivered the unit fuel cost will be:

$$\frac{1{,}000 \times \$5}{7 \times 2{,}000} = 35.7\text{c. fuel cost.}$$

The fuel cost with oil will be found as follows: Assume that fuel oil costs 2½c. a gal., and the factor of evaporation is 1.05. The efficiency and therefore the fuel cost per thousand pounds of steam will depend upon the size and type of boilers and settings used, the load factor, type and make of burner equipment, and the intelligence of operation.

Assume an efficiency of 75 per cent. Then with fuel oil of 18,500 B.t.u.;

$$\frac{1{,}000 \times \$0.025}{(\text{actual evap. per lb.}) \times (\text{lb. per gal.})} = \text{Fuel cost}$$

of evaporation.

Actual evaporation per lb. of oil will be $\frac{75\% \times 18{,}500}{1.05 \times 970}$ = 13.62 lb., and the weight of this oil per gallon may be 8.1 lb. Substituting these values in the above formula gives a fuel cost of 22.7c. per thousand pounds of steam.

The coal cost in the case just cited was 35.7c. The saving in fuel bills will therefore be $\frac{35.7-22.7}{35.7}$ = 36.4 per cent. This example represents the approximate conditions and costs in the New Jersey plant mentioned before.

With other values for the prices and B.t.u. contents of coal and oil, and other conditions, this saving might become a loss. With still other conditions the savings might easily approximate 40 per cent or more.

To insure success a correct and impartial diagnosis must be made of each individual case. There is no short cut which does not risk failure and waste of time and money.

If a coal-fired boiler plant is very efficiently operated, say with modern stokers or pulverized coal, it may not be possible to make any gain in efficiency by substituting oil. If, however, oil can be bought at a sufficiently lower cost per million B.t.u., the change would still show a saving. Also, if the load factor in such a plant were low and the load highly variable, with sudden large demands and considerable banking periods, the oil fuel would show additional economies over the stokers, but probably not over pulverized coal firing.

The greatest savings for oil lie mostly in the field of the small- and medium-sized industrial plants. This field represents a golden opportunity for rehabilitation of the sort that pays about 50 per cent on the investment.

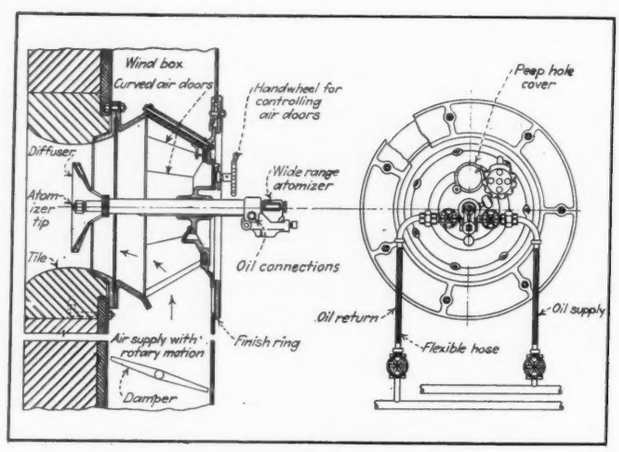


Figure 2—One of the several ways of atomizing oil is to force it under high pressure through a small hole

The reason that such opportunities are not immediately grasped is mainly because owners of these plants do not know their cost for a thousand pounds of steam. Nor is there in their organizations sufficient technical knowledge and experience to attack this important problem successfully. Yet a fairly simple study would reveal the facts.

The oil usually available for steam making is known as "Bunker C," which covers a multitude of sins. Formerly, fuel oil was crude oil from which the lighter portions had been distilled. Such oil is available today, and is known as "topped oil." But Bunker C may also be obtained from refineries where cracking is employed.

Topped fuel oil free from water, salt, and sulphur increases in heat content per pound as its specific gravity decreases. A pound of lighter oil gives more B.t.u. than a pound of heavy oil. But, since oil is bought by gallons

*From author's paper, Transactions Am. Soc. H. & V. Engineers, Jan., 1920.

or barrels, a gain in weight is obtained by buying the heavier oil. Thus, a gallon of heavy oil contains more heat than a gallon of lighter oil, and costs less.

The relationship is shown in Figure 1, but it must be remembered that many fuel oils sold as Bunker C will not adhere to this scale, owing to processes of production other than "topping" and to natural impurities.

The general specifications of Bunker C prescribe a flashpoint, Pensky-Mortens' test, minimum of 150 deg. F. and Furol Viscosity at 122 deg. F., maximum of 300 seconds.

Because of the variations in fuel oil its Baume or gravity is not always a measure of its viscosity, which has an important effect on combustion and on the type of burner to be selected. An oil of high viscosity or high resistance to flow must be preheated to a higher temperature than one of low viscosity.

In general, there are three distinct types of oil-burning systems, each with its advantages and disadvantages. An intelligent selection of the type best suited to the human and physical conditions of a given plant is essential to successful operation.

A great deal of unnecessary trouble can be borrowed if a certain quite usual course is followed. This procedure is to let it be known that an oil-burning installation is under consideration; collect proposals from manufacturers; listen to sales arguments; and then purchase one of the cheapest propositions.

It is strange that this plan is so often followed, and not strange at all that trouble and dissatisfaction result from it. Everyone bids on something different. Hence the comparison of price is on a false basis. All three types of systems, with variations, will be represented and the wrong one is frequently purchased.

Good, reliable oil burner companies who have bid honestly on the real needs of the plant will lose the job because others have cut corners and prices.

When the wrong type of burner has been bought it may not be long before a bagged boiler or burned-out furnace lining gives the first warning of trouble ahead. Even the proper burner installed without due consideration of furnace form and volume and kind of boiler may produce the same sad results. The economy of the plant may be crippled because of insufficient oil storage or inadequate auxiliary equipment.

Again, the first warning may take the form of a gas explosion in the setting, or refusal of the equipment to handle the various types of Bunker C on the market.

Fifty other things may go "hay wire" and the 50 per cent return may vanish, or become a 50 per cent loss. None of these things need happen.

Many plant improvements have been ably conceived, but some necessary link in their execution was omitted which caused the chain to break. This is as unfortunate as it is unnecessary, for such incomplete planning has hurt the cause of sound and economical rehabilitation.

The three types of oil burners are:

1. Mechanical-pressure atomizers, Figure 2, which spray the oil into a mist by forcing it, preheated to a relatively high temperature, under high pressure through a small aperture in the burner tip. The latter is located at the center of a circular air-admission damper of the stationary wheel-blade type. The blades impart a whirling motion to the air in order to produce an intimate mixture of oxygen and fuel.

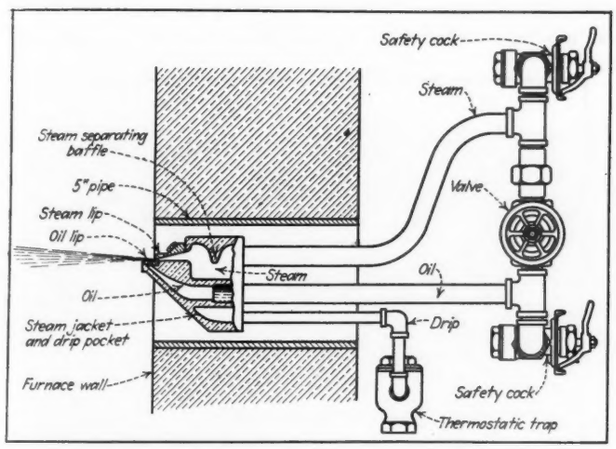


Figure 3—In this type of oil burner a jet of steam does the atomizing

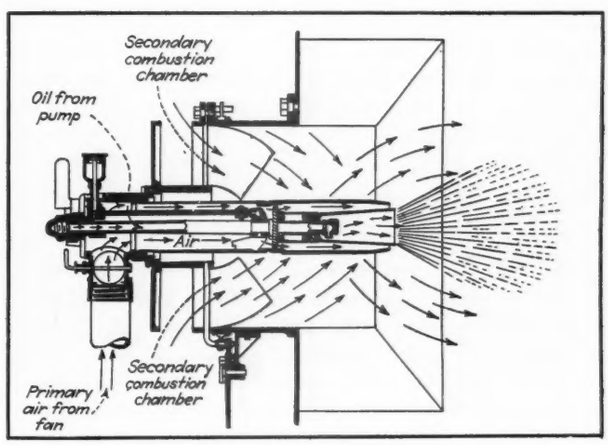


Figure 4—Here centrifugal force throws off the oil in the form of a fine mist from an air-driven cup that rotates at high speed

2. Steam atomizers, Figure 3, the simplest of all types, cause atomization by direct contact of steam with the oil. The designs vary widely. They operate in general with considerably lower oil temperatures and pressures than the mechanical-pressure types.

3. Rotary-cup type of oil burner, Figure 4. This type depends for atomization on the centrifugal force exerted upon a film of oil kept supplied to the inside surface of a metal cup which spins at a high rate of speed.

Incidentally, the rational adaptation of oil burning is only one of at least a hundred different possibilities for reducing operating costs in factory power plants. The intelligent selection and use of such opportunities is the mark and the reward of the successful plant owner of today.

· MANAGEMENT SHORTS ·

Raise for Foremen

When a new packing department was laid out at Foulds Milling Co., Libertyville, Ill., an innovation was tried in locating the foreman's desk. It was placed, together with the departmental stockclerk's desk, on a platform 42 in. above the floor and at one side of the room, midway along the outside wall. The flat-top desks face the room. Thus was solved the problem of permitting these men to perform their necessary pencil work, while at the same time keeping an eye on the activities in the department. The elevation gives them a clear view of every operation and machine line in the room, which is 100 by 118 ft. The foreman can see every one of the 75 operators, and the men can see him. If a machine line stops, the foreman knows it within a few seconds.

While the purpose of the plan was not to encourage spying, the management has noticed a wholesome moral effect on the worker. There is likewise an excellent effect on the foreman, since he is no longer subject to the temptation to retire behind his tall roll-top in the corner when tired of being on his feet. He walks far less, and his supervision is at least twice as intensive as before.

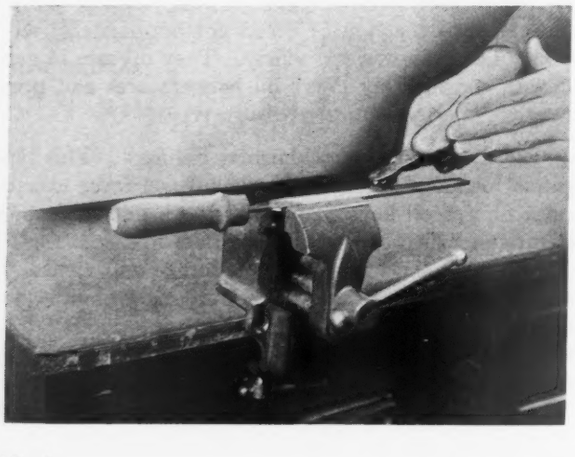
•

Product life may be checked in many ways. One out of every so many Westinghouse Mazda lamps is forced to die. Burned at 50 per cent overvoltage, it lives a thousand hours in five.

•

Filed to a Turn

I have found, writes one of our readers, that quite often it is necessary, in shaping up some small metal part with a file, either to waste considerable time by alternately clamping it in the vise and loosening it again, or to adopt some special means. The "special means" is to clamp the file in the vise as shown. If the part being filed is so small that the operator cannot get a good grip on it with his fingers, it can be gripped in a pair of pliers, and yet be quickly shifted in order to get the proper contour.

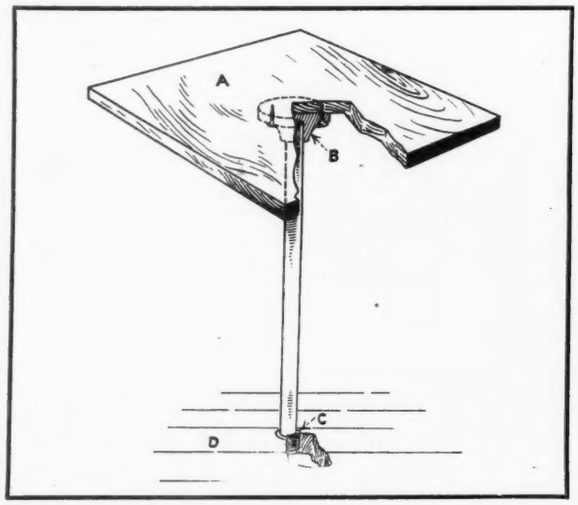


•

How Many Legs . . .

. . . should a work table have? Four-legged tables teeter unless the floor is as level as a billiard table. Three-legged tables sit level enough, but they tip over when least expected.

These drawbacks led one company to do some experimenting with small work tables of the type convenient to place at machines and work stations. The result is a one-legged affair like the table shown in the accompanying drawing. The leg is just a piece of threaded pipe which is screwed into a pipe coupling set into the



floor. Lo! a rigid table that doesn't tip over at inopportune moments—and a table that can be moved at an instant's notice if it ever gets in the way. J. E. HYLER

•

Up at Niagara Falls, the Chisholm Ryder Works saves 4,000 kw.-hr. a month, reduces lamp replacements one-fourth, improves production, has fewer accidents—all because it controls factory lighting photoelectrically.

•

Price of Progress

"We urge our men to read," says the progressive manager of a steel fabricating plant. "Never have the technical magazines contained such a wealth of excellent,

really practical material. I tell them they can go to a university at home."

"How about the men who don't read?" he was asked.

"Well, we've got to have followers as well as leaders, I suppose."

"But if you give a man responsibility for leadership, you expect him to continue to earn the right to lead?"

"Right."

•

Double Check

Two tests occur simultaneously in testing transformers at Stewart-Warner Corporation, Chicago. This is made possible by an ingenious arrangement of the testing equipment.

The primary purpose of the test station is to assure the quality of transformers used in the radio receiving sets. At the same time it is important that all the wires be of the proper lengths when they go to be assembled into the set.

These wires must, in testing the transformer, be clipped into terminals. These terminals are accordingly set at distances which check the exact length of the wires. If the wire won't reach, the transformer is rejected for this cause. If it is too long, the tester clips it off.

•

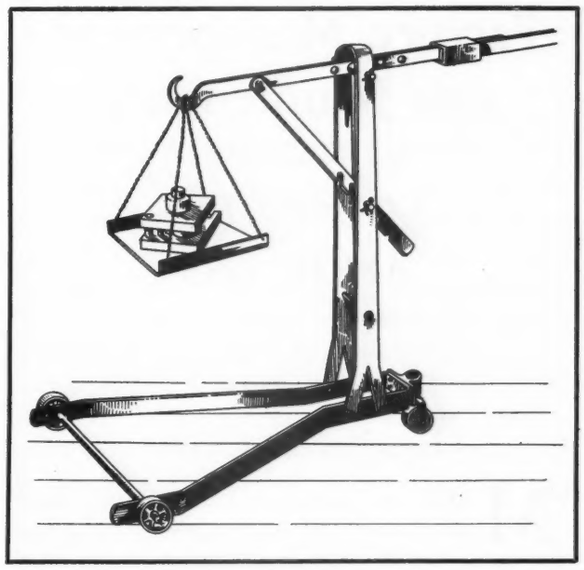
STEP INTO THE CORNER FOR A TASTE OF ARIZONA

Paper that protects food must itself be protected against the caprices of the weather. So in this laboratory the Kalamazoo Vegetable Parchment Paper Co. tests its papers and inks by simulating conditions in Panama, Labrador, and New York. Our geography fails to mention the location of Utopia where temperature and humidity are at all times ideal.

•

In Heat It Shuts

At each steel bench in the packing room at Abbott Laboratories, North Chicago, Ill. (see March, page 91), there is a tilting excelsior bin, also of steel. When open, the bin is off balance, but is held open by a chain with a fusible link. The link parts at the first hint of fire in the bin, the bin slams shut, and the fire burns itself out harmlessly.



Punch Puller

The sketch shows how easily someone in the shop can build a portable crane that will make the die-setter's job a simpler one, and save time handling tools in and out of presses, or to and from toolrooms. The crane is built on the principle of the old lever jack; has a notched prop to hold the arm where you want it.

CHAS. H. WILLEY

•

If "mountain" air and its attendant—so they claim—invigorating effects can be had in the Roxy Theater in Radio City, why not in industrial plants where there's many a job of air conditioning to be done? The ionization machine, which may some day be bringing the wide-open spaces inside the factory, is industrial research's reproduction of nature's method of purifying air.

•

MOVING DAY IN THE MACHINE SHOP

This lathe weighs all of 29 tons. But that doesn't stop the tractor you see tugging away in the photograph from moving it easily and safely from here to there. That's just one of the jobs a tractor can do around the plant. It juggles iron rods and steel sheets, helps to load bulky materials onto flat cars—even keeps yards and driveways free from snow, if you are bothered that way.

Factory Management *and* Maintenance

A consolidation of *Factory and Industrial Management* and *Maintenance Engineering*

L. C. MORROW, Editor

APRIL, 1933

•

Equipment Curios

"MANY of yesterday's best sellers have become curios in a museum." For the quotation credit Philadelphia's *Evening Bulletin.* True as to wearing apparel, household appliances, conveyances—most common commodities.

Applies, also, to industrial plant equipment. Easily apparent when "50 years ago" is taken as yesterday. Less obvious when yesterday means "before the depression." Approaching truth, nevertheless. Product engineers and equipment manufacturers have not been on holiday the past three years.

•

Toward Prosperity

GOODRICH (rubber products) announces restoration of salaries to rates effective prior to the recent financial emergency. In last month's issue we commented on similar action by Wrigley. Our comment applies again, so we repeat: "Every concern possessing the surplus or the income that will permit taking the same course should fall in line. Wage [and salary] earners do the bulk of the buying, can't buy on a prosperity basis without proportionate incomes."

•

Purchasing Power

PROFITS from many streams make up most of the available capital, through which, as money or credit, we set up and run our industrial mechanism. When capital floods it finds its way into unneeded and overexpanded enterprises, whose output overburdens the market. There is such a thing as glutted capital (as we witnessed in our boom years) but there has been no concerted public attempt in America to divert the streams that feed it into an ampler flow of wages—into the great source of purchasing power, which this very process has artificially shrunk. Spending and saving (reinvesting) must be put in balance. We shall be compelled to open up increased consumption by such a concerted move or drift into state socialism, communism, or some other form of collective economic life in which the profit incentive may be wiped out altogether; however much many of us regard such a course as unsound.

You have just read a paragraph by Samuel S. Fels in *Survey Graphic*—his article Planning for Purchasing Power. Mr. Fels didn't write it as an editorial. We think it is, and so let it stand.

•

To Let

ONE OF the oldest and largest of the International Harvester Company's many plants has been closed. The work is to be transferred and the building rented, if possible, for light manufacturing. Obviously a sensible thing to do.

We hear much of over capacity. It would be a healthful thing for many businesses to realize that much of their capacity is in reality junk. The company might then rid itself of the cost of maintaining, and moving its work through, acres of dead assets. It could condense its good modern equipment into a compact and economical plant and, if and when business justifies expansion, build tomorrow's plant to fit tomorrow's need.

•

Facts Needed

SEVERAL years of low production volume, falling prices, much keen-eyed scrutiny of plant operation costs. Inevitably power costs are receiving more and more attention.

In many plants the question of whether to make or buy power is a live one. There are plenty of other plants in which it ought to be. Important, it needs careful handling.

There are advantages in purchasing central station power; generating power locally has its advantages. The nature of these advantages and their comparative importance will vary with the conditions peculiar to each plant. It follows that an intelligent decision in favor of

one or the other policy cannot be based on snap judgment, prejudice, generalities, hearsay. There must be painstaking analysis of all of the many factors that enter into such a problem.

It is no undertaking for an amateur; nor is it a problem that can always safely be intrusted to the partisan interests of those who have something to sell. If the requisite knowledge and experience are available in the plant, well and good. If they are not at hand, it will pay to seek them outside.

Sound advice is almost always worth a great deal more than it costs.

•

Water Is Cheaper Than Watts

THE PHRASE is a lamp manufacturer's. He estimates that intelligent maintenance —mainly soap and water—would wipe approximately $300,000,000 off the national lighting slate.

Always slow to bandy our hundreds of millions, this time we gain comfort from the knowledge that we could go wrong by a naught and still leave a healthy score for good maintenance.

•

Buying Chiseler

DEPRESSION tends to bring back the old days of "let the buyer beware." It's largely the buyer's own fault, because he has become a chiseler.

Everyone knows the means and methods of the buying chiseler. And everyone knows that lowered quality will result if chiseling is carried far enough.

"It's his own funeral if he sells below cost," says the buyer, when he launches his drive on the manufacturer for lower prices. So it is, and if that manufacturer is honest with himself and his stockholders he will go to the funeral with quality standards maintained.

Not all manufacturers are quality-scrupulous; not all are quality-informed. Despite a general high order of business ethics, the old evil crops out; prices are cut, quality goes down with them, and the buyer, chiseling and non-chiseling, suffers.

A manufacturer of a nationally known commodity, combating price chiseling, has this to say: "Carried further, this process will bring the solid rock of quality crashing down upon the buyer and throw open the markets of the world to unscrupulous manufacturers who regard the worshipers of price as their lawful prey.

"The debasement of quality can mean only the lowering of performance standards and a deeper drain upon incomes—the major variable cost-factor that still remains. Which means in turn the flight of consumer purchasing power and unfortunate social consequences."

Forcibly expressed—probably not exaggerated. We need rising, not falling, prices—and very much more consumer purchasing power.

•

Industrial Farmers

IS THE Goodrich co-operative garden plan indicative of a broad development to come? Look at the 1932 record: Nine hundred men worked 150,000 man hours, produced 1,000,000 pounds of vegetables. All of which were consumed by the growers. No surplus for sale or barter. No disruption to established channels of food distribution, because the workers had nil in buying power.

Perhaps farming by necessity will give industrial workers a taste for farming by choice. If industrial workers become part-time farmers, why shouldn't farmers become part-time industrial workers? Would this splitting of occupations mean moving the farms to the plants or the plants to the farms? What of decentralization? Location with respect to raw materials and centers of consumption?

The ramifications possible in such a plan have their appeal—the plan has its advocates. Deserves at the least a corner in the subconscious.

•

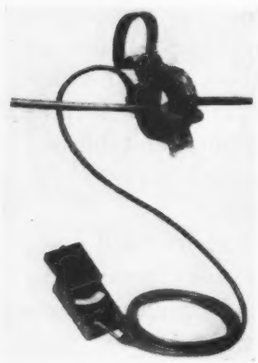
Penalty or Plain Sense?

IT TOOK place in New York. Pressing machines went in and 200 hand pressers went out. Each dismissed worker took with him a $10 dismissal wage—is to collect the same amount each week for seven more weeks. The $80 per worker will be a virtual penalty charge against the labor-saving equipment.

This action may be a weather vane; at any rate makes a beginning of solving the problem of caring for technological replacements during transition.

Management and maintenance need to know many facts that only electrical instruments can tell them about plant, process, and equipment operation

for FACTS



With a split-core transformer and an ammeter, current readings can be taken quickly, without interrupting service

HEATING of a 50-hp. motor on a punch-press, caused trouble, although the motor was apparently of ample size. A recording instrument showed a 65-hp. peak at every stroke, with a minimum load of about 5 hp. The motor was found to be of a low-resistance, and hence low-slip, type. It was doing the punching and fighting the flywheel. After tests were made, a 20-hp. high-resistance motor was installed. The recording instrument then showed 25-hp. peaks and 18-hp. minimums. The motor fed the flywheel; the flywheel did the work, because the motor speed gave way sharply under peak loads. The motor ran cool; the demand was reduced.

This incident is typical of countless others. Electrical testing instruments show up the facts wherever trouble is apparent. They will show what kind of trouble is brewing, and where, so that repair and maintenance costs can be kept down. In the average industrial plant, the expenditure of a small amount of money in essential instruments is almost certain to bring greater returns than those from any other similar investment.

A great variety of instruments have been perfected for special purposes. Certain of these instruments are essential in specific industries. This article, however, will discuss only the ordinary instruments that are useful in the great majority of industrial plants.

Operating temperatures of motors, transformers, and other devices are much discussed, because high temperature, like fever, is a symptom of trouble. Several Centigrade thermometers should be on hand for temperature readings.

The thermometer that reads room temperature should be located near the apparatus being investigated; the bulb should be submerged in oil in a heavy container, such as a pipe fitting, to avoid fluctuations from casual drafts. Thermometers applied to equipment should be tied in place to prevent breakage. The bulb should be attached to the metal with common putty, using only enough to cover the bulb and make contact with the metal.

In the accompanying table are shown the safe ultimate temperatures for various classes of insulation. Excessive temperatures of equipment may indicate overloads in current or output, or local resistance heating caused by some defect, and call for investigation that is thorough.

One of the most frequently used instruments is a voltmeter. For practical use a multiple-range instrument reading up to 750 volts is convenient. The higher scale connection should be tried first, if there is any doubt as to the voltage being tested. It is possible to extend the range by the use of multipliers, which are simply external resistances. Unless the multipliers are built for use with the particular instrument, care should be taken to see that they are non-inductive, of sufficient capacity, well insulated, and that the wire has a negligible temperature coefficient. Then:

True Voltage = Meter Reading ×
[(Res. of Instrument + Res. of Multiplier)
÷ (Res. of Instrument)]

If one side of the line is grounded, the instrument should be connected to that side. Where possible, on

If anything is the matter with these husky bending rolls or their motor, the meters will find it out. At the left, a recording ammeter; right, an indicating voltmeter

R. H. Rogers

Industrial Engineering Department
General Electric Company
Schenectady, N. Y.

ASK METERS

220 volts and over it is well to ground the instrument at the binding post marked "±." Use of extra long leads should be avoided, since a lead resistance of only 0.025 ohm is included in the calibration.

With alternating current, voltages beyond the meter range may be read by the use of a potential transformer. Then the voltage equals the meter reading times the transformer ratio.

Persistent low voltage may indicate a ground, whereas intermittent low voltage, as when a motor is started, may indicate low power factor or excessive inrush current. The voltmeter is usually the first aid in locating and diagnosing trouble.

An ammeter is a low-resistance instrument; it should be connected in series with the load—never across it. The double-range instrument is the most useful. When in doubt connect to the higher range first; then, if it reads too low, switch to the lower range. Connect to the grounded side if there is one. If conditions warrant, the instrument should be grounded.

The range of an ammeter may be extended by the use of a current transformer, which will also serve to insulate the instrument from high voltages. The standard current transformer is built for a secondary current of 5 amp. and is for use with 5-amp.-range instruments. The true current values are determined by multiplying the instrument reading by the ratio of the transformer.

Millivoltmeters read thousandths of a volt and are made in several ranges, the 200 range being commonly used. They are used to measure direct current by the voltage drop across a known resistance which may be internal or external. Amperes can be read directly from the scale if the instrument is calibrated for that particular resistance; so care should be taken not to introduce errors by the use of leads of higher or lower resistance than those furnished.

For direct-current power the product of volts times amperes equals watts; dividing by 1,000 gives kilowatts. Kilowatts input to a motor may be converted to horsepower output by the formula:

Horsepower = Kilowatts × Motor Efficiency.

Thus, if the input is 74.6 kw. and the efficiency of the motor is 90 per cent:

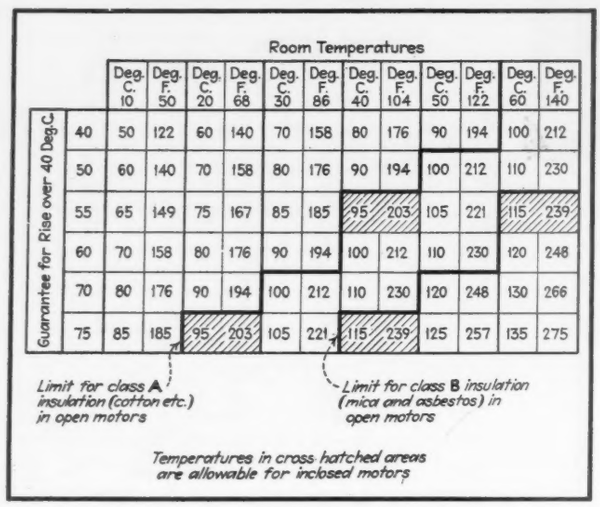
$$\frac{74.6 \times 0.90}{0.746} = 90 \text{ Horsepower}$$

Handy for testing around the plant. This kit contains an ammeter, voltmeter, split-core transformer, and leads

For single-phase alternating current the product of volts times amperes times power factor equals watts. The procedure for finding horsepower output is the same as for direct current.

For three-phase alternating current the product of volts between phases times amperes in one phase times $\sqrt{3}$ (1.73) times power factor equals watts. Horsepower output is determined as with direct current.

For reading watts directly a wattmeter, obtainable for single-phase or polyphase service, is used. It is essentially a torque motor consisting of a two-coil rotor and a two-pole stator. Two terminals are connected across


Room Temperatures
Deg. C. 10
Deg. F. 50
Deg. C. 20
Deg. F. 68
Deg. C. 30
Deg. F. 86
Deg. C. 40
Deg. F. 104
Deg. C. 50
Deg. F. 122
Deg. C. 60
Deg. F. 140
Guarantee for Rise over 40 Deg.C.
40 50 122 60 140 70 158 80 176 90 194 100 212
50 60 140 70 158 80 176 90 194 100 212 110 230
55 65 149 75 167 85 185 95 203 105 221 115 239
60 70 158 80 176 90 194 100 212 110 230 120 248
70 80 176 90 194 100 212 110 230 120 248 130 266
75 85 185 95 203 105 221 115 239 125 257 135 275
Limit for class A insulation (cotton etc.) in open motors
Limit for class B insulation (mica and asbestos) in open motors
Temperatures in cross hatched areas are allowable for inclosed motors

Safe ultimate temperatures for insulation

the lines and two are connected in series with the load. Multipliers can be used with wattmeters, the same as with voltmeters. Watts and, therefore, horsepower can be determined without knowing the power factor. It is well to protect the wattmeter by trying the circuit first with a voltmeter and ammeter. The "±" post of the potential circuit must be connected to the same side of the line as the current leads.

With a voltmeter, an ammeter, and a wattmeter, power factor can be determined. Power factor equals:

Watts ÷ (Volts × Amperes) or,

Actual Power ÷ Apparent Power

In a balanced three-phase circuit, voltamperes equal amperes per line times volts between lines times 1.73.

Power factor meters read power factor directly and are similar to wattmeters. Single-phase instruments can be used only at their rated frequency, but polyphase power factor meters are independent of frequency, within commercial practice.

Resistance up to 2,000 ohms or so can be read on ohmmeters. They are available in a variety of full-scale ranges from 1 to 2,000 ohms. High insulation resistance or dielectric strength is measured in megohms (millions of ohms). The instrument used contains a hand-cranked magneto which impresses potential on the insulation to be tested. The material or device under test is connected between the two terminals and the resistance is read directly from the scale. If one side is grounded, that side should be connected to the instrument terminal marked "ground."

The insulation resistance in megohms of a machine at its operating temperature should be at least:

Rated Voltage ÷ (Rating in Kw. + 1,000).

Thus, for a 125-hp., 2,200-volt motor the instrument should show at least:

2,200 ÷ (100 + 1,000) = 2 megohms.

When checking speed, one can count "by hand" up to 200 r.p.m. with a little training, but most speeds are too high for this method. There are several types of revolution counters and tachometers available and some such device should be used. The tachometer reads directly in r.p.m. and shows fluctuations in speed. Revolution counters are timed for a minute to determine the speed in r.p.m. They do not show variations in speed on short cycles.

The preceding discussion refers to indicating instruments, which show momentary values only. Recording instruments are available that make a running record of events over a long period. The advantages are:

(1) The results may be taken as the average of many readings, thus avoiding errors caused by unwittingly taking readings during temporary conditions.

(2) A long series of readings can be secured without taking the investigator's time.

(3) The exact relation of a series of events can be determined in a way impossible to duplicate otherwise.

A spring-driven clock or a small synchronous motor may be used to drive the paper roll. Instruments can be procured with 60-ft. rolls 6 in. wide, of which 5 in. are available for the record. Speeds may be adjusted for 1, 3, 6, or 12 in. a minute, or an hour. Ammeters, voltmeters, wattmeters, power factor meters, and others are available in the portable recording types.

Portable instruments, indicating and recording, have found valuable applications in machine-tool studies, plant power surveys, time studies, and in production work in general. However, their use by the maintenance department is probably the most profitable.

For permanent, continuous records—the graphic meter. This one is a single-phase wattmeter, with synchronous-motor drive for the chart. Meters of similar design are available for recording volts, amperes, frequency, or power factor

Clerks in Link-Belt's Chicago plant don't have to "go traveling." The revolving table brings everything to their desks. Saves space, too. The upright panels carry completion dates and shipping schedules

And for the plant office layout

MOTION ECONOMY

*William Conroy**

Production Manager, Link-Belt Company, Chicago

▸▸ ***Link-Belt did to factory office layout what Cadillac and others have done out in the shop (See "What Motion Study Did to Plant Layout," by F. J. Van Poppelen in Factory and Industrial Management for December, 1931, page 797)***

OFFICE work constitutes a larger and larger percentage of total manufacturing costs, and this company recently decided to see whether these costs could not be reduced at its Pershing Road plant.

In our engineering type of business, with a great variety of work and many special orders, we write a general order covering the job and listing the various parts to be made. Copies of this order are sent to the various foremen concerned and also serve, with suitable extensions or additions, as cost, shipping, routing, and other copies. The individual items are also copied and such details as piece-rate price and machine number added as necessary for time cards, requisitions, material tags, and so on.

The first step in our analysis was to develop flow sheets or process charts showing in succession every step taken in handling and filling the order. Examined in this way, the number of clerical operations was unexpectedly large. As a result of this study a master form was designed which, with a second sheet for long orders, consolidated or eliminated seventeen forms previously used, and required only one writing.

We next turned our attention to the layout of the shop office. It is located between the machine shop and the structural steel shop, with a dispatch window opening into each shop, and with desks for the two general foremen inside.

The old layout is shown in Figure 1. It was on conventional rectilinear lines. We did with it what recent shop layouts have done with machines. We disregarded the conventional pattern and arranged desks to give

*As reported by H. P. Dutton

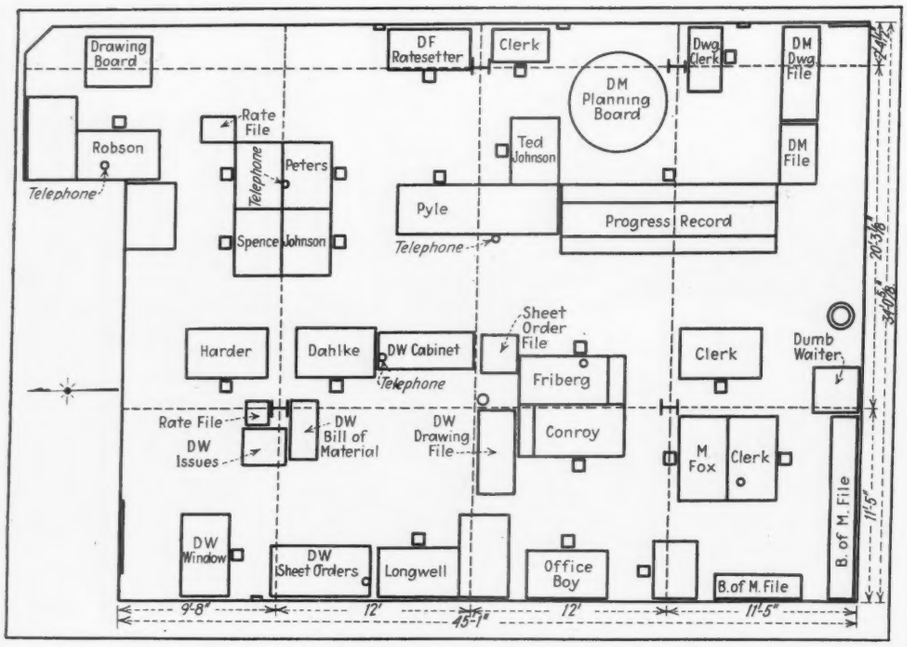


Figure 1

Everything shipshape. Desks arranged in orderly rectilinear fashion. But like any other factory office of pre-motion-economy days. Too many clerical operations. Too much jumping up and walking around. Link-Belt's first move was to chart every step taken in handling and filling an order. Result, a master form has now replaced seventeen pieces of paper that used to make a fairly simple job hard

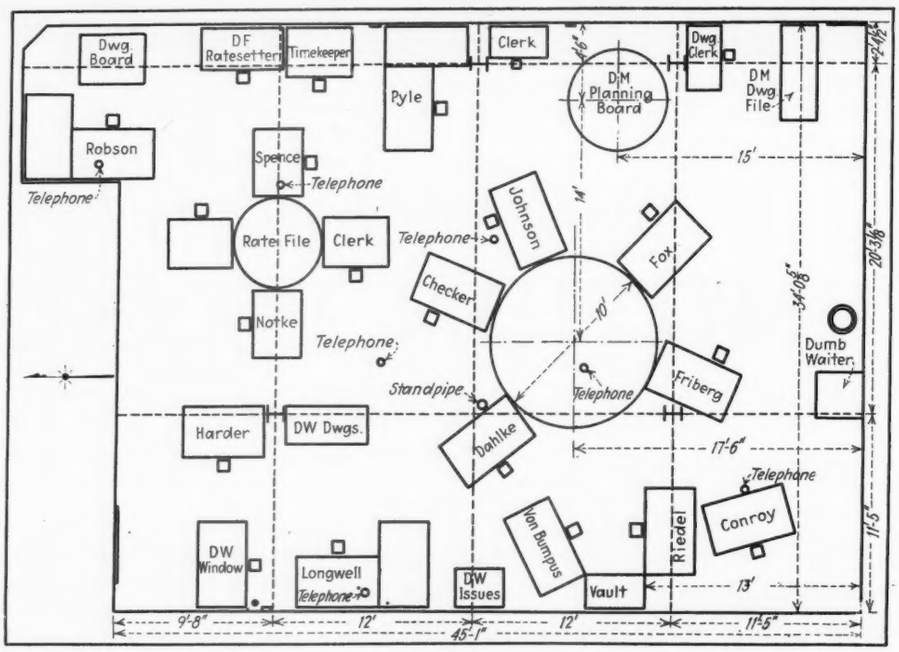


Figure 2

Now look. Gone is conventional layout. Here the principles of motion economy have been applied to office layout. Revolving file, with desks placed radially, speeds up the rate setters' work. Files for combined route sheets and progress sheets have been placed on large revolving table. Clerks receive completed time cards from dispatch clerk, post them to record without leaving seats

easiest access to the material worked on. (See Figure 2.) For the rate-setters' desks, this meant a small revolving file for rate data, with the desks placed radially.

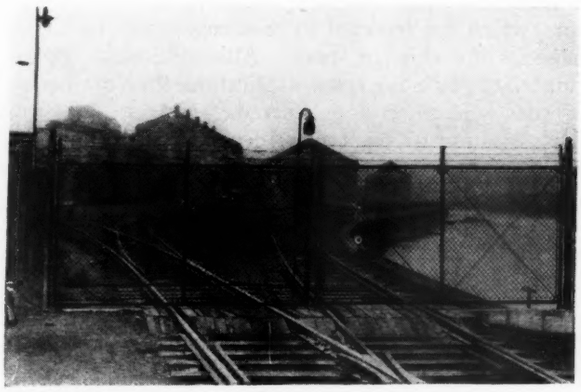
As for the combined route sheets and progress records, we put the files on a large revolving table. This table, placed between the machine shop planning window and the structural shop window, permits the clerks from either department to receive a completed time card from the dispatch clerk and to post it to the progress record without leaving their seats. Follow-up men also work at this table, which enables them to check the progress of orders rapidly and easily.

Even with present volume, these changes substantially reduced the travel and distraction in the office, besides giving the production manager a more effective and centralized control of the work of the department.

The large circular table for the progress records is shown in the accompanying photograph. Both it and the revolving, octagonal planning boards seen in the central background were built in our own shops. The table is built like a wheel. A stout central hub rolls easily on a thrust bearing and two axial roller bearings. Attached to the hub are $1\frac{1}{2}$-in. angle-iron spokes, braced umbrella-fashion by lighter angles. Around the periphery of the wheel is a circular table made of $\frac{1}{8}$-in sheet aluminum, on which light aluminum angles are riveted as guides for the books. Four small bulletin boards, set vertically along the inner diameter of the table, carry the schedules of shipping dates for orders in the shop. Desks are placed so that each man sits with the table immediately at his left or right, and can bring the desired book to his desk at a touch.

• MAINT-O-GRAPHS •

Equipment efficiency • Ideas • Plant problems • Design developments



Stop! Gates Closed

WALTER WENDELKEN, Supervisor of Lighting Equipment
Westinghouse Electric & Mfg. Company, E. Pittsburgh, Pa.

Large gates were installed at the boundary of the company's property to permit locomotives to pass in and out. Previous to the installation of the stop or warning light several locomotives went through the closed gates and broke them down, because at night it was hard for the engine crew to see whether the gates were open or closed. Since the light has been installed no trains have gone through the gates and the expense of repairing or furnishing new gates has been eliminated.

The warning light consists of a 5-in. ruby Fresnel lens mounted in an aluminum housing and controlled by a waterproof door switch mounted at the hinges of the gate. The light, therefore, always burns when the gates are closed.

Construction Change Solves Synchronous Motor Trouble

CHAS. A. PETERSON, Mishawaka, Ind.

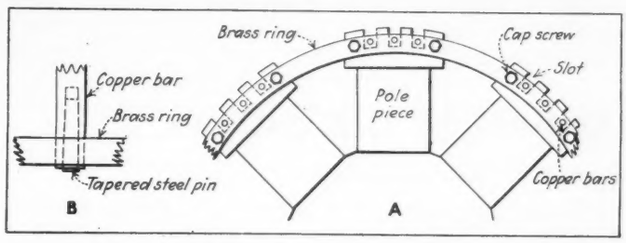
Some time ago I was called upon to correct trouble which had developed on a 300-hp. synchronous motor. This motor originally was purchased as an alternator, but after a few years' service it was shipped back to the manufacturer to be rebuilt as a synchronous motor. For a time after its return to the plant it operated in a fairly satisfactory manner, except that it had poor starting characteristics.

Shortly before my arrival, however, this motor became very difficult to start, eight or ten men being required to pull on the belt each time it was started.

Examination showed that in order to place a squirrel-cage winding on the revolving fields of the alternator each polepiece had had slots approximately $\frac{1}{2}$ in. wide machined across the outer face in which round copper bars made from bare No. 000 trolley wire had been inserted. The ends of these bars had been put into two brass short-circuiting rings to complete the winding, as shown at *A* in the sketch. Tapered steel pins *B* were driven into holes in the ends of these copper bars to make a tight joint with the brass rings.

Many of these bars had become loose and several were broken, so that when the motor was started severe flashing took place at these breaks.

The machine was repaired by installing new bars of



No. 000 bare, hard-drawn copper trolley wire. The ends of the new bars, tinned carefully before insertion, were peened over on the outer surface of the brass rings, to eliminate the use of the steel dowels. After peening the copper bars the joints were soldered carefully. From then on the machine started with no difficulty.

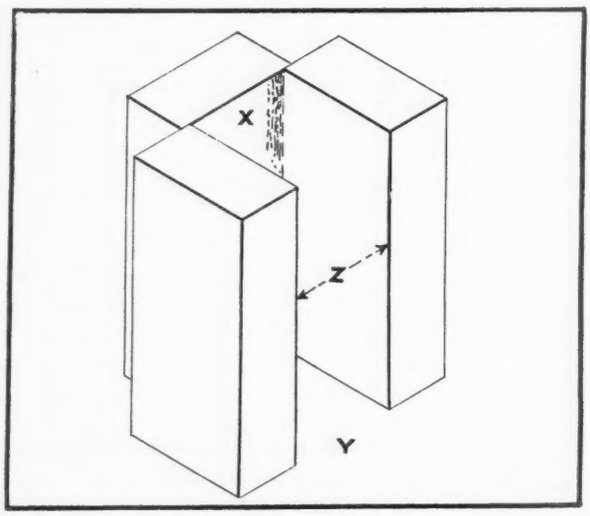
Neglected Maintenance

S. G. Hibben, Westinghouse Lamp Co.: "Lighting . . . . . had become unsatisfactory. The intensity at the desk top level was measured and found to be only 3.75 foot-candles. First, the reflectors were cleaned. Foot-candles increased to 4.6 in. Then, lamp bulbs were installed, which raised the intensity to 5.26 foot-candles. Finally, the ceiling and walls were repainted. The final reading showed a total increase of 81 per cent in the light intensity over the first reading."

Quick Furnace from Bricks and Blowtorch

With three good bricks and a blowtorch you have the material needed for an emergency furnace, for heating crucibles and soldering irons, or to fill any like need. The bricks deflect the flame upward and serve as a support for the object being heated.

Set the bricks on a level surface with top ends flush. If necessary to block one or more of them up at the



bottom, do so. The blowtorch is set at *Y* and the flame is directed against the back brick at *X*. To accommodate larger or smaller pots, the dimensions *Z* may be varied to suit.

Finishes for Hot Surfaces

HERBERT CHASE, Forest Hills, N. Y.

Three important factors often are overlooked when finishing surfaces exposed to heat within a temperature range of from 150 to 350 deg. F., such as steam pipes, radiators, or ducts carrying heated air. These factors concern (1) the effect of the finish upon the quantity of heat transferred, (2) the tendency of the finish to peel, and (3) the tendency of the finish to discolor.

Few maintenance engineers appear to realize that, if the radiators in a given room are given a final coat of metallic paint, such as bronze, gilt, or aluminum, the quantity of heat given off may be reduced as much as 17 per cent or more. Metallic paints are those which contain flakes of the metal in question, as distinct from those containing an oxide or a salt of which the metal is only a part.

Unless exceptionally heavy coats of paint are employed, it is only the final coat that affects radiating capacity. Consequently metallic undercoats have practically no effect upon the amount of heat radiated. If it is desired to reduce the heat lost by radiation from a hot surface, it can be done to some extent by applying a metallic final coat, but of course the effect of such a coat is small as compared to that of asbestos and other heat insulating materials.

When radiators are placed close to a cold outside wall, the surface facing the wall may well be finished with metallic paint. This paint will reduce to some extent the heat lost in direct radiation to this wall, which has little effect upon warming the room. It should be kept in mind that an increase in heating capacity presupposes an adequate supply of steam, for the additional heat can come only from the extra supply of steam. In other words, the radiator cannot radiate heat at a higher rate unless the heating plant is adequate to supply this additional heat.

Unless the primer adheres closely to the metal it is likely to check and peel carrying with it the succeeding coats. One of the best primers for black and galvanized hot metal surfaces is made according to the following formula: In a vehicle consisting of 80 per cent raw linseed oil, 15 per cent thinner, and 5 per cent oil dryer is mixed a pigment composed of 80 per cent (by weight) of zinc dust and 20 per cent of zinc oxide.

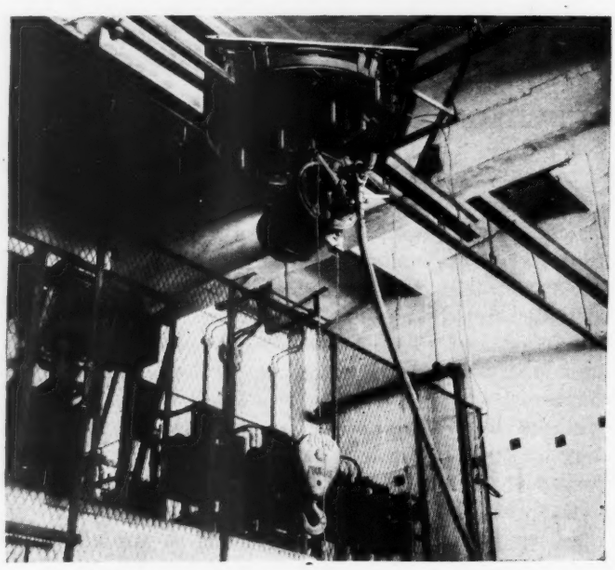
Among the best final coats for radiators are some of the modern glyptol enamels, available in a variety of colors, which are reported to be exceptionally free from tendencies to chip or peel. Although most glyptol enamels are made for spray application, they can be had for brush application if so ordered.

Discoloration of paint films depends partly upon the discoloration of the oil in the paint and partly upon the pigment used. Discoloration, of course, is especially noticeable in white and light colors and usually appears sooner on heated than on unheated surfaces. For these reasons, pigments having high hiding power and freedom from discoloration through chemical action should be chosen for use on hot surfaces.

Hot surfaces near ceilings often are painted white, both to increase natural light reflection and to make the objects less conspicuous against the white background of the ceiling itself. In this case titanium oxide pigment has a decided advantage because it resists discoloration and because of its good hiding power.

Monorail Turntable Saves Time and Space

A 2-ton electric hoist in the heat treating department of the aluminum foundry of the Wright Aeronautical Corporation can be switched from one monorail to another one at right angles to it in a few seconds by use of the monorail turntable shown. Two suspended wires are used to control the unit. When the first one is pulled the latch that locks the movable rail in place is released and, when the other wire is pulled, the turntable rail turns through 90 deg. and locks automatically.



Dual-Voltage Connections for Induction Motors

A. C. Roe

Railway Engineering Department
Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Three-phase star series and parallel connections, twelve to eighteen poles

IN THE February issue *(Maintenance Engineering)* rules were given for constructing schematic-line diagrams for two-phase series and parallel connections, twelve to eighteen poles. This article will discuss three-phase star connections for motors having twelve to eighteen poles, with directions on how to use dual-voltage diagrams for single-voltage connections.

For the arrangement of groups Table I of the article in the November issue should be used. Instructions for connecting the leads to the line were given in Table III in the first article (July, 1932, issue).

For twelve poles there are four possible dual-voltage star connection diagrams: (1) Series and two-parallel star, Figure 1. (2) Two-parallel and four-parallel star, Figure 2. (3) Three-parallel and six-parallel star, Figure 3. (4) Six-parallel and twelve-parallel star, Figure 4. The first three diagrams have been laid out as indicated in Figure 1*A* to permit the use of additional jumpers when desired in order to secure full equalization.

Referring to Figure 1*A*, the B phase is shown as arranged for the two-parallel star connection, with equalizing jumpers connected between the group jumpers. Care is necessary in applying the equalizer connections to insure that the proper points of equal potential are connected together and that these points are spaced in such manner that when current flows the unbalanced pull will be equalized by other groups. With star connections it will be necessary when adding equalizer jumpers to use one internal jumper to connect together the two separate star connections. This jumper is shown in Figure 1*A* as the star jumper.

To equalize the two-parallel star connections of Figure 2 only four additional jumpers per phase would be needed, since leads *L4* and *L7* connected together also form an equalizer connection.

The three-parallel star connection of Figure 3 can be equalized by the use of rings instead of jumpers; there would be two rings per phase. Ring *1* for the A phase would have all points marked *1, 2,* and *3* of groups *1, 4, 13, 16, 25,* and *28* connected to it. Ring *2* would have points *4, 5,* and *6* of groups *7, 10, 19, 22, 31,* and *34* connected to it. Connecting leads *L4* and *L7* together would form the third equalizer connection.

There are only two dual-voltage star diagrams possible with fourteen poles. These are: (1) series and two-parallel star, Figure 5; (2) seven- and fourteen-parallel star, Figure 6. When connecting a winding according to the diagram in Figure 6 it would be advisable to use rings to connect the groups together.

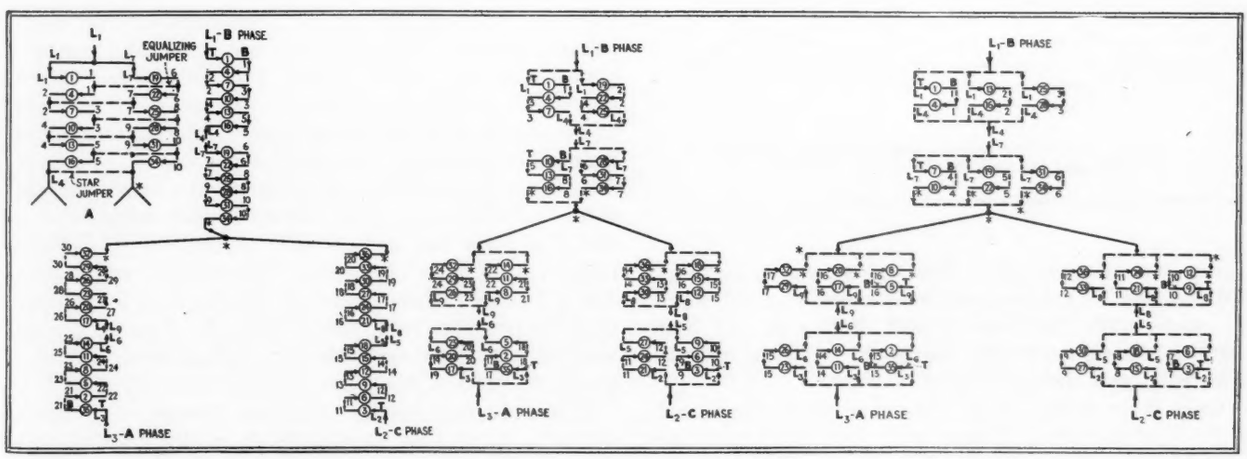


Figure 1 — Three-phase, twelve-pole, series and two-parallel star diagram

Figure 2 — Three-phase, twelve-pole, two-parallel and four-parallel star diagram

Figure 3 — Three-phase, twelve-pole, three-parallel and six-parallel star diagram

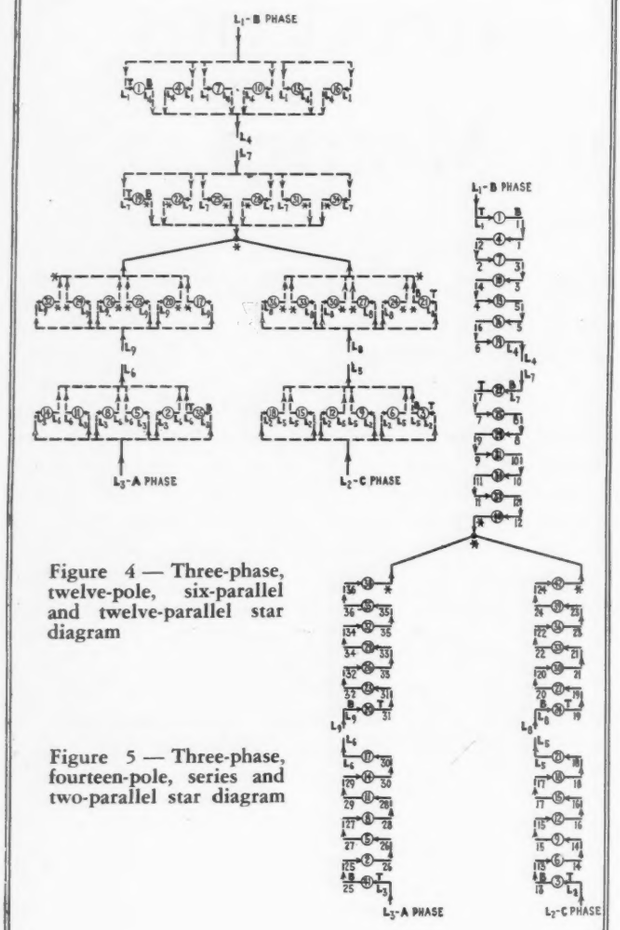


Figure 4 — Three-phase, twelve-pole, six-parallel and twelve-parallel star diagram

Figure 5 — Three-phase, fourteen-pole, series and two-parallel star diagram

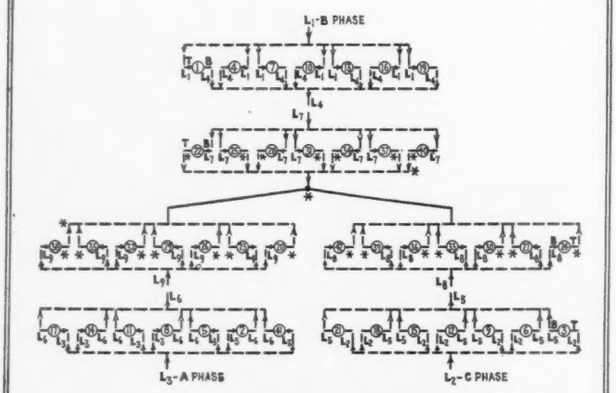


Figure 6 — Three-phase, fourteen-pole, seven-parallel and fourteen-parallel star diagram

For sixteen poles four dual-voltage star connections are possible: (1) series and two-parallel star, Figure 7; (2) two-parallel and four-parallel, Figure 8; (3) four-parallel and eight-parallel, Figure 9; (4) eight-parallel, Figure 10, and sixteen-parallel.

Only three dual-voltage star connections are possible with eighteen poles. These are: (1) series and two-parallel star, Figure 11; (2) three-parallel and six-parallel star, Figure 12; (3) nine-parallel and eighteen-parallel star, Figure 13. However, these three diagrams give six different connections, or all the connections possible on eighteen poles, if considered as single-voltage connecting diagrams.

Converting Dual- to Single-Voltage Diagrams

Dual-voltage schematic-line diagrams can be converted to three-lead, single-voltage diagrams with very little trouble. Referring to Figure 1, a series-star, three-lead connection can be made by connecting together the tops of groups *16* and *19* in the B phase, instead of bringing out the two leads *L4* and *L7*. Likewise, in the C phase the tops of groups *18* and *21* are connected together by a jumper, instead of bringing out the *L5* and *L8* leads. In the A phase, the tops of groups *14* and *17* are jumped together instead of bringing out *L6* and *L9* leads.

Instead of marking the tops of groups *16, 19, 18, 21, 14,* and *17* as *L4* and *L7* and so on, a number can be used similar to that employed to mark the jumper between other pole-phase groups. This number should be a continuation of the jumper numbering system. Thus, for Figure 1, the tops of groups *16* and *19* would be marked *31*; tops of groups *18* and *21* marked *32*; tops of groups *14* and *17* marked *33*, as will be seen.

For a two-parallel star, single-voltage, three-lead connection, Figure 2 can be taken as an example of the method used to make the changeover. The simplest method would be to mark the diagram with red ink as follows: Instead of *L4* and *L7*, mark these points *25*; points *L5* and *L8* should be marked *26*, and points *L6* and *L9* should be marked *27*. Hence, there will be four points of like number that will be connected together. If single jumpers are considered to be more economical disregard the *L4* and *L7* and like connections and, using the next jumper number, add the jumper number for each leg. For example, in Figure 2 the bottoms of groups *7* and *10* should be numbered *25*, groups *25* and *28* should be numbered *26*, and so on.

The same reasoning can be applied to Figures 3 and 4 for the three- or six-parallel connections. Note that for the lower voltage connection the corresponding connection on the next diagram is used because it simplifies things somewhat. For example, for a two-parallel star, single-voltage, three-lead connection Figure 2 is used rather than Figure 1, since the star connections are made internally and the chances of mistakes are reduced.

To convert the low-voltage connection of any dual-voltage diagram to a single-voltage, three-lead connection, consult the table (Table III, July, 1932 issue) giving the line lead connections, and make the changes in the diagram in red ink to permit internal instead of external connections. Assume that it is desired to change the six-parallel connection in Figure 3 to a single-voltage, three-lead diagram. Table III states that leads *L4, L5,* and *L6* form the second star; therefore, all groups marked *L4, L5,* and *L6* should be re-marked with a star. The *L1* and *L7* leads connect to the B-phase line; hence all *L7* points are re-marked *L1* and all *L8* points are re-marked *L2*. Then re-marking all *L9* points as *L3* completes the process as applied to the C and A phases.

Since the dual-voltage diagrams present all possible connections, without exceptions, it is obvious that with the data given above for converting to single-voltage connections, this series of articles will give complete coverage of all connections from two to twenty-four poles.

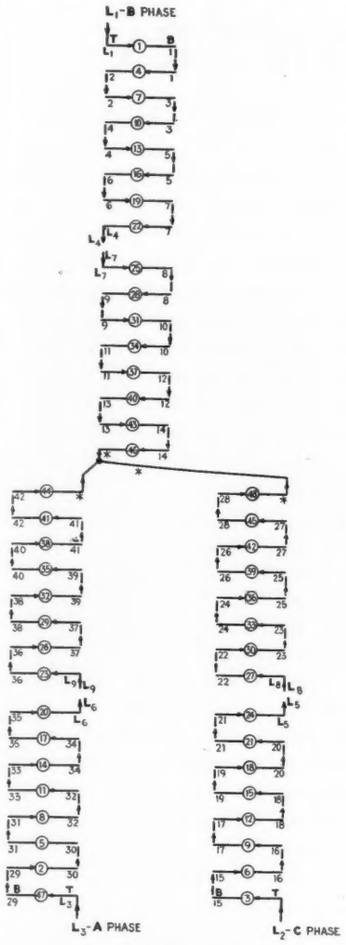


Figure 7—Three-phase, sixteen-pole, series and two-parallel star diagram

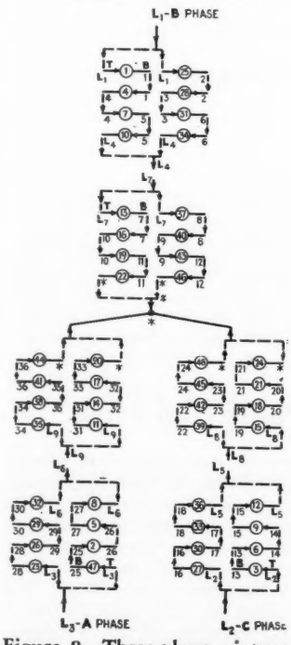


Figure 8—Three-phase, sixteen-pole, two-parallel and four-parallel star diagram

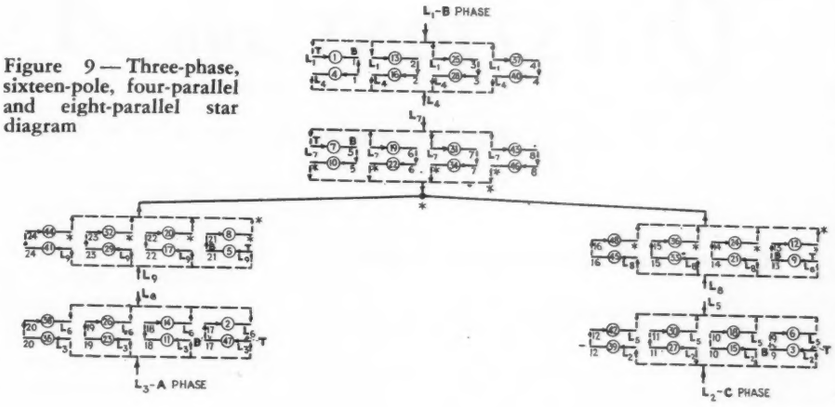


Figure 9 — Three-phase, sixteen-pole, four-parallel and eight-parallel star diagram

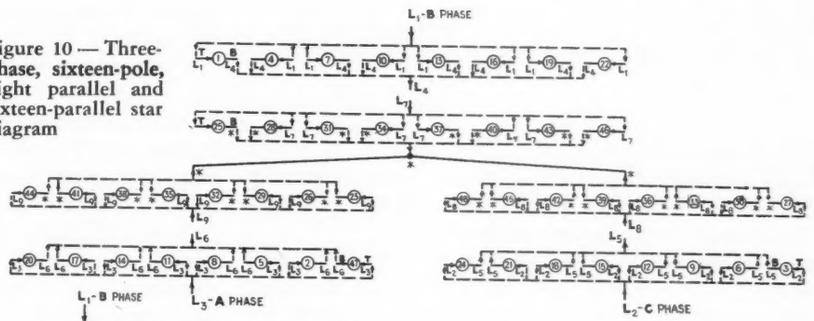


Figure 10 — Three-phase, sixteen-pole, eight parallel and sixteen-parallel star diagram

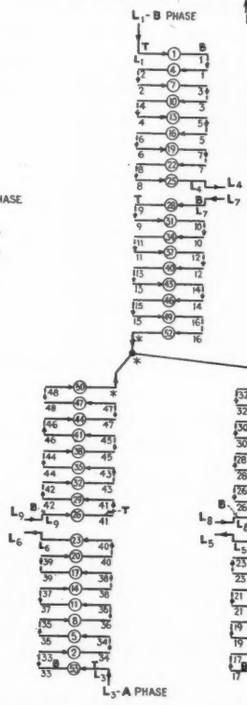


Figure 11 — Three-phase, eighteen-pole, series and two-parallel star diagram

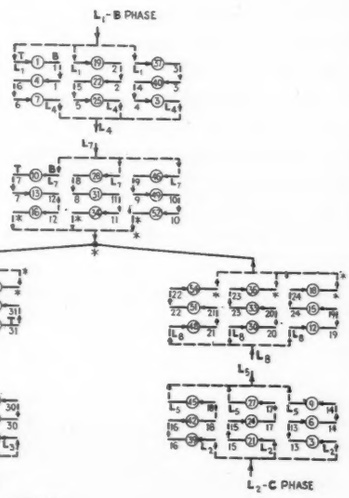


Figure 12 — Three-phase, eighteen-pole, three-parallel and six-parallel star diagram

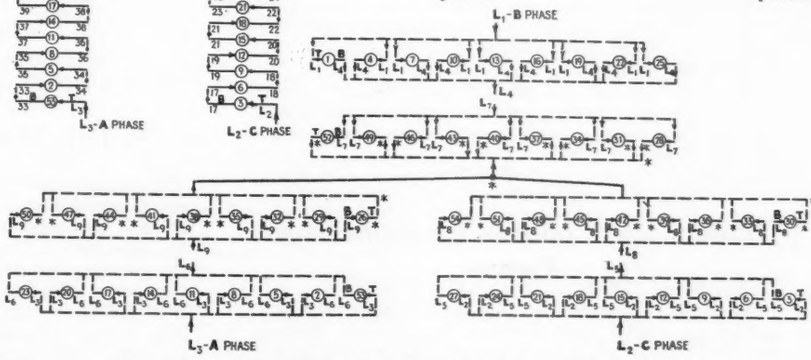


Figure 13—Three-phase, eighteen-pole, nine-parallel and eighteen-parallel star diagram

QUESTIONS and ANSWERS

Conducted by G. A. VAN BRUNT

How to Make Lubrication Survey

It has been suggested that ways of saving money might be revealed by a thorough study of our lubrication problems and requirements. Ours is a metal-working plant, handling small and medium-sized parts. About half of our equipment is driven from lineshafts; the remainder is driven by separate motors. Some equipment, including part of the motors, has ball bearings, but plain bearings are used mostly. From their experience can readers tell me how to make such a study? What information should be collected? O.M.E.
Detroit, Mich.

GOOD lubrication may be defined as "The selection and application of that lubricant which will give the lowest bearing temperature with the lowest consumption of power when under full load."

Since about half of the equipment is driven from lineshafts, I believe that the best way to get the most efficient lubrication would be by the comparative method: Make the study on a similar machine equipped with an individual motor and then use the same lubrication methods and lubricant on machines driven from the lineshaft. If it is desired to have the study include machines run from lineshafts, the power input for the lineshaft alone should be taken when the machines are idle and under average working conditions. In any case a study of the power input and lubrication of the lineshaft alone should be made.

Power input to the lineshaft motor may be determined with a graphic wattmeter for any period of time during the test. Take a reading for, say, ten minutes before working hours in the morning and at noon; then, as a check, immediately after working hours at night when all machines are idle. This test will give the power requirements for the lineshaft alone. The lubricant may now be changed on the lineshaft and the power requirements determined again. Repeat the process until the most efficient lubricant has been found.

For applying the lubricant, almost any of the standard devices may be used that will contain sufficient oil to give an adequate supply between trips of the attendant. The amount of oil applied should also be regulated by test, since supplying too great an amount is fully as wasteful and costly as an insufficient amount.

Now determine the power input to any machine or group of machines when running idle. Test the machines again under full load. When all of the machines or groups have been tested and the results charted, change the lubricant and test again, continuing until a lubricant of the proper viscosity has been selected. Generally, it will be found that a lubricant of lower viscosity can be used than has been the custom.

If the lubricant is to be selected by the comparative method, the test may stop when the power input has been determined and the lubricant chosen for the lineshafts, and continued by using a machine driven by an individual motor to obtain the proper lubricant for the machines.

(Continued on advertising page 28)

ANSWERS WANTED

Incentives in Maintenance Work

It has been suggested that we could reduce maintenance costs by applying a bonus or incentive system. The maintenance department claims that incentives are not applicable to its work. We operate both woodworking and metalworking machinery. I should like to have the experience of others on this subject. In particular I should like to know what savings have been made, and the general classes of maintenance work to which some form of incentive can be applied.
Chicago, Ill. G.F.K.

Motors and Controls for Centrifugal Pumps

We plan to install two centrifugal pumps, one to be driven by a 5-hp., and the other by a 10-hp., 220-volt, 60-cycle motor. Current will be supplied by a 20-kva. m.g. set. The motors will be controlled automatically by float switches. Although the starting loads will be light, the lowest possible starting surge is desirable because of the low capacity of the current supply. Will someone tell me the best type of motor and starting equipment for this job? Would a slipring motor with a three-point automatic starter be satisfactory? Please compare this with other types of starters that might be used here and give the advantages and disadvantages of each.
Lake Placid, Fla. A.E.A.

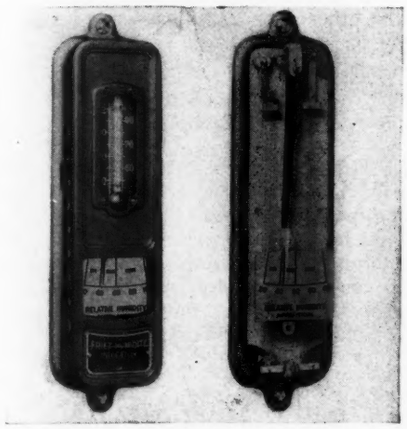
Is This Motor Pulley Too Large?

We had to change a motor for one of different rating, and to avoid obstructions and obtain the desired lineshaft speed it was necessary to use a motor pulley larger than the diameter of the armature. It has been objected that this is not good practice because more stress is put on the motor, although it does not appear to be overloaded. Will the use of this pulley be harmful to the motor? We have always used motor pulleys not less than one-third nor more than two-thirds the diameter of the armature. Is there any real basis for this practice?
Terryville, Conn. P.F.A.

· EQUIPMENT NEWS ·

Humidity Indicator

Fifty-four human hairs mounted, treated, and individually ventilated, constitute the actuating element. Graduations in percentages of relative humidity.



The instrument is housed in a pressed-metal case, cadmium plated, and finished in gold lacquer. Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.

Waterproofing

A transparent material which can be applied to either wet or dry surfaces at any time, above 32 deg. F.; termed "Masterseal All Weather Waterproofing." Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio.

Duplicating Machine

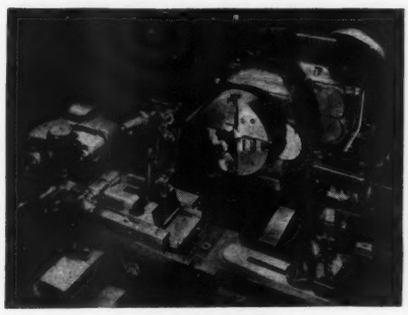
"Copy Kit" is hand-operated, but embodies the principles of the larger duplicating machines. Capable of producing 100 copies from one original. Everything necessary for copying is included in the kit, which measures 18 x 10 x 2½ in. Ditto, Inc., Chicago, Ill.

Motor Reducer Unit

Combination motor and gear unit for speed reduction and speed increase, designed for relatively low ratios. The motor frame supports the gearing, a single helical train, the gear housing being rigidly connected to the stator. The take-off shaft is generally located directly above and in line with the center of the motor, but can be positioned to either side or below. Timken roller bearings are used on the low speed shaft and a solid roller type bearing is used for mounting the pinion end of the motor. Available for capacities up to 15 hp., and in 18 standard reduction ratios and 4 standard step-up ratios. The Falk Corporation, Milwaukee, Wis.

Centrode Device

This device makes it possible to turn, bore and face ovals, triangles, squares, hexagons and octagons, and any shape up to sixteen sides, either flat, concave, or convex. Stroke capacity ranges from 0 to 2 inches. The number of flutes or tool actuations per revolution of spindle in divisions from 1 to 16 is set on an index plate. The device is supported on the carriage bridge in the same manner as a compound rest. By means of the cross-feed screw the unit can be positioned for diameters. Power is developed from the rear end of the spindle



through a universal joint and spiral bevel pinions to the compound crank of the actuating tool slide. The Monarch Machine Tool Co., Sidney, Ohio.

Photoelectric Controller

A light-sensitive control called the "Photo-Troller," especially adapted to applications such as counting, door opening, automatic weighing, use as limit switch, and similar operations. The phototube, or sensitive contact, operates a grid glow tube which in turn closes a contactor capable of initiating any desired operation. The device is assembled in a sheet metal cabinet with door and knockouts. Units are available for any commercial voltage or frequency—not d.c. The device contains a complete power supply for all auxiliaries, including the light source. Light sources are available to operate the control at distances up to 22 ft. from the phototube. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Voltage Tester

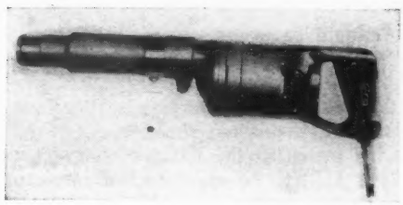
Requires no lamp; registers accurately the voltage as well as indicating whether it is a.c. or d.c. A fiber case prevents danger to operator. Long rubber-covered lead wires are provided with supporting springs at the entrance to the tester housing to prevent breakage. Sharp points make it possible to pierce the insulation of wire without destroying it. Square D Co., Detroit, Mich.

Centrifugal Separator

Designed for continuous clarification or separation of liquids containing a relatively high percentage of solid material. One of the features of this unit is its ability to discharge solids or bowl cake while running at full speed. The Sharples Specialty Co., 23rd & Westmoreland Sts., Philadelphia, Pa.

Electric Hammer

Double-purpose tool called the "Thor" electric hammer for drilling, chipping, and channeling concrete, brick, wood, and similar material. It will also chip steel and drive light rivets. Specifications: 3,000 blows per minute; overall length, 18 in.; weight, complete, 16 lb. A ¼-in. chuck, ⅜-in. Star drill, toolholder and ejector pin, and carrying



case are included with each tool. Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.

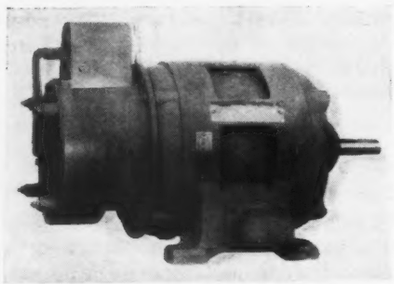
Conveyor Belt Idler

Timken roller bearing idler, 6 in. in diameter, available in both troughing and return roller types. Troughing type consists of three pulleys, supported by malleable iron brackets and a self-

cleaning angle base. All three are interchangeable. Return rollers are of the conventional, flat, one-piece type with steel supporting brackets. Construction in both models includes threefold labyrinth grease seals and grease reservoirs. Idlers are available for belts 14 to 60 in. in width. The Fairfield Engineering Co., Marion, Ohio.

Magnetic Brake

Will operate at any angle, attached to any motor without changes in design; available in sizes up to 4,000 ft.lb. Only one solenoid, operating at high



leverage, is used. Shock-absorbing devices relieve the solenoid from shock, either upon opening or closing; d.c. or a.c. of any frequency may be employed. Wrought Washer Mfg. Co., Milwaukee, Wis.

Needle Files

Knurled handles in place of smooth, round handles, prevent slippage; available in all regular shapes and sizes. American Swiss File & Tool Co., 410-416 Trumbull St., Elizabeth, N. J.

Cement

Liquid porcelain cement available in three consistencies; a paste for application with trowel, a dipping cement suitable for dipping, spraying or brushing, and a dry powder ready to be mixed with water to the desired consistency. It is said to be an electrical insulator and proof against water, oil, acids, gases, and heat up to 2000 deg. F. Henry L. Crowley & Co., 1 Central Ave., West Orange, N. J.

Plastic Rubber

High-grade rubber in paste form, packed in tubes. It is not a rubber cement, and contains no flammable solvents. Can be thinned by adding water. Uses: Mending electrical insulation, leather, rubber hose, rubber belting; making insulation, joint packing, rubber gaskets, weatherproofing, and other shapes of this nature. Frund Rubber Co., 154 East Erie St., Chicago, Ill.

Insulated Wire

Vega refractory (Chromoxide) insulated wire is copper wire having a refractory heat-resistant coating consisting chiefly of inorganic material which is baked on the surface of the wire. The insulation is a refractory chromium compound produced by the reaction of chromium oxide and an inorganic binding material applied to the wire at a high heat, in combination with a water-insoluble, organic binding material used for structural purposes. The space factor is comparable to enameled wire. American Enameled Magnet Wire Co., Port Huron, Mich.

Turbine Ventilators

Wind and electrically driven turbine ventilators constructed of galvanized sheets protected by aluminum paint. Electrically driven units are powered by a geared-head repulsion-induction motor, connected to the ventilator by a clutch which operates on the free-wheeling principle. When power is off the rotor revolves freely about the center bearing. Motor and clutch are mounted on top of the rotor out of the path of exhaust. The Allen Corporation, Detroit, Mich.

Portable Manhole Ventilator

For driving off obnoxious gases from manholes, tunnels and other inclosed places where electric power is not available. The blower, delivering 1,550 cu.ft. of air per minute, is powered by a ¾-hp., air-cooled, gasoline engine mounted on heavy coil springs to cushion vibration. Air flow can be directed by means of an 8-in. diameter flexible tubing. Weighs 105 lb. The Coppus Engineering Corp., Worcester, Mass.

Duplicating Machine

Electrically operated, rotary duplicating machine, automatically self-feeding and self-ejecting. It makes 50 or more copies from one original at the rate of more than 100 a minute. Any size paper, up to 8½x14 in., can be used and as many as eight colors can be reproduced.

Duplicator is mounted on an enamel cabinet of convenient height. Case contains drawer space for Ditto films, inks and other materials, and storage space for paper. Ditto, Inc., Chicago, Ill.

Receptacles

"Ever-Lok" receptacles, plugs and cord connectors with automatic locking, positive grounding by double phosphor bronze springs, dustproof, sponge-rubber washer. Receptacles are sealed to conduit boxes by gaskets, and have gasket-lined, hinged flat doors. Russell & Stoll Co., New York, N. Y.

Ball-Bearing Saw Rig

Portable, ball-bearing, tilting table saw rig for ripping, cross cutting, dadoing, mitering, bevel cross cutting,

double mitering and bevel ripping. The rig has a straight line cutoff and an adjustable arbor shaft. Powered by a 10-hp. four-cyl. gasoline engine. Crankshaft and arbor shaft have ball bearings. Chain Belt Co., Milwaukee, Wis.

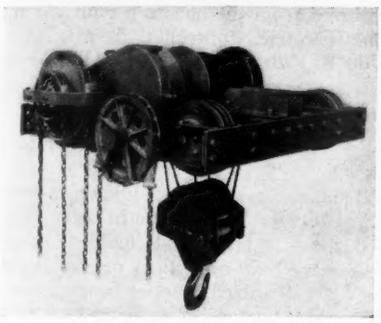
Neon Lamp

This Neon glow lamp for signal indicator service is designated Type N-1, has a G-6 bulb, and a candelabra screw base. The lamp has no ballast resistance inside the base. External resistors, like those generally used in the radio trade, can be placed in series with the lamp socket. The lamp will begin to glow at 85 volts, a.c., and 110 volts, d.c. Only one electrode, the negative, will glow on direct current, making it

possible to use the lamp as a polarity indicator on direct current. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Hoist

"Cyclone" two-speed, wire rope, drum hoist is designed for applications where headroom is limited and maximum lift



is required, for use on a double I-beam, overhead traveling crane. Capacities from 3 to 30 tons. Loads are held by means of disk brakes. Hoisting mechanism operates in grease bath, in oil-tight housing. Chisholm-Moore Hoist Corp., Tonawanda, N. Y.

Glass Coating

"No Glare" is a liquid glass-coating for windows to reduce heat and glare of direct sunlight; weather-proof, but easily removed. It may be painted or sprayed on, and dries quickly. The Skybrite Co., Cleveland, Ohio.

Screw Drivers

With solid, forged, one-piece blades, heat-treated, and taper-ground tips. Fluted handles of transparent composition are non-conductors. Five styles, thirteen sizes. Bonney Forge & Tool Works, Allentown, Pa.

Lamp Cord

Rubber-sheathed cord for electric lamps, clocks and other semi-portable devices. Trade-marked "No-Fray." Available in brown or black, with soft rubber plugs to match. Belden Manufacturing Co., 4689 West Van Buren St., Chicago, Ill.

Motorized Reduction Unit

Called "IXL Powered Gear." From ½ hp. to 150 hp., ratios from 2 to 1, to 3,600 to 1, with right-angle, straight-line or offset drive, either horizontal or vertical. The worm-gear type covers ratio ranges from 4 to 1, to 60 to 1, single-reduction style, and up to 3,600 to 1 in double worm-reduction type. The helical-gear type is available in single-, double-, and triple-reduction ratios, providing output speed ranges from 4 r.p.m. to 850 r.p.m., and horsepower capacities up to 150 hp. Foote Bros. Gear & Machine Co., Chicago, Ill.

High-Speed Steel

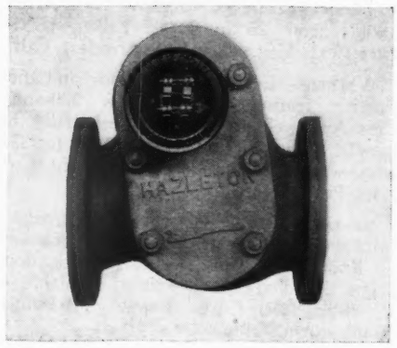
Called "Dissteel," for use in planer knives. It has the same hardness as high-speed steel, but is said to give better resistance to the friction and abrasive action developed in planing, when the knives strike the surface of the lumber at great speed. Henry Disston & Sons, Inc., Philadelphia, Pa.

Electric Hoist

Made in four sizes from ¼ to two tons capacity. Specifications: Automatic balancing hook, push button control, safety type limit switch, spur gear drive, positive automatic brake accessible from the outside, oil bath lubrication, universal type motor coupling, special steel drop-forged swivel hook, special alloy chain tested to 300 per cent overload. Coffing Hoist Co., Danville, Ill.

Check Valve

Fitted with a Mercoid flow switch, and designated as "Type M," this valve



is used to shut down a pump if it loses its water during operation. Barrett, Haentjens & Co., Hazleton, Pa.

Rubber-Base Plastic

"Plioform," a rubber-base plastic from which electrical parts, kitchen appliances and a wide variety of molded products can be made. The material is pure pale crepe rubber dissolved in a solvent and mixed with a filler. Addition of pigments produces a wide range

of colors, including both black and white. Claimed for this material is its resistance to physical deterioriation or discoloration from light exposure. Goodyear Tire & Rubber Co., Akron, Ohio.

Welded Boiler Tubes

"Electrunite" resistance welded boiler tubes, formed from strip steel. Available in all sizes up to 5 in. outside diameter, in copper-bearing nickel steel, Toncan iron, and open-hearth steel. Steel and Tubes, Inc., Cleveland, Ohio.

Overload Breaker

The "Knockout" overload breaker is for protection of fractional-horsepower, single-phase motors. The case is of Bakelite. Over-all dimensions are 2 7/16 in. high, 1⅜ in. wide, 1¾ in. deep. Breaking mechanism is of thermal, melting alloy type. Contacts are silver-to-silver, single-pole, double-break. Maximum rating is ¼ hp., 110 or 220 volts, a.c. Square D Co., Industrial Controller Division, Milwaukee, Wis.

Flexible Coupling

Known as the "RC"; consists of two cut-tooth sprocket wheels, or coupling halves, and a piece of roller chain with pin and cotter link to connect them. Can be inclosed in either a stationary or revolving, automatically lubricating, oil-retaining casing. Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.

Electric Drill

Portable electric drill for light duty. Drill body and handle are cast aluminum. Special alloy, heat-treated, gears operate in a grease-tight chamber. Driven by a Universal motor for 110 volts, 25 to 60 cycles, at a no load speed of 1700 r.p.m. Equipped with a "make-and-break" switch, and a three-jaw chuck with a capacity up to ¼ in. Furnished with 8 ft. of heavy-duty, rubber-covered cord, with rubber plug and key.

Weight 6 lb., length 11¼-in., diameter 4 in. Signal Electric Mfg. Co., Menominee, Mich.

Houghton Takes Over Weaver Brothers

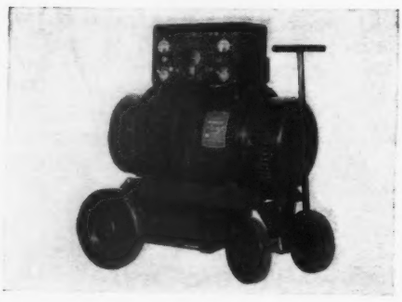
E. F. Houghton & Co., Third, American and Somerset Sts., Philadelphia, Pa., announce that they will manufacture and sell the products formerly made by Weaver Brothers Co., Cleveland, Ohio. Weaver products include pickling inhibitors, pickle pills for testing the strength of acid and alkaline solutions, "Tanktite," a plastic acid-resisting lining for tanks, and several other products used in the pickling of metals.

Protected Motor

Self-protecting motor suited for automatically controlled devices such as refrigerators, oil burners and air conditioners. The protective device is a small disk type thermostat mounted on the motor frame, which opens the circuit when the motor gets too hot and connects it again after the motor has cooled. The one moving part in the thermostat is a circular bimetallic disk which buckles at definite temperatures, opening contacts when it heats and closing them when it cools. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Arc Welders

Available in capacities ranging from 5 kw. (125 amp.) at 40 volts, to 24 kw. (600 amp. at 40 volts) with electric motor or gasoline engine drive, as well as for pulley or coupling drive. Fea-



tures are reverse polarity switch with double scale meters, selective reactance, and remote control. Hobart Brothers Company, Troy, Ohio.

Cement Cleaner

"Cement cleaner and renovator (92-P)" is a non-flammable, non-poisonous concentrated base from which liquid floor cleaner can be made. For oil or grease-soaked cement floors and driveways. Available in 130-lb. kegs and 400-lb. drums. Magnus Chemical Co., 13 So. Ave., Garwood, N. J.

Speed Reducers

"Planigressive" spur-gear speed reducers and increasers for N.E.M.A. frame motors. Units include standard spur gears and a double revolving gear ring. Available in ratios from 3 to 1 to 360,000 to 1, for either horizontal or vertical motors. Right-angle drives are also available. Planigressvie Reducer Co., 2737 So. 28th St., Milwaukee, Wis.

Geared Motor

Self-contained geared transmission and an asbestos-protected motor mounted integrally on a pedestal base. For speeds from 2 to 10,000 r.p.m. Helical gears and pinions, inclosed. Labyrinth seals to prevent oil leakage. Gears or the electric rotor unit may be removed without disturbing the other members. Anti-friction bearings. U. S. Electrical Mfg. Co., Los Angeles, Calif.

Safety Switch

Called Type "A," and designed for severe duty. Made with quick-make and quick-break, double-break, semi-floating V-blades and steel back-up springs on the V-stationary contacts. The door is interlocked with the operating handle. Mechanism is assembled on a single base, held in the box by four screws. The entire switch may be removed from the box to permit wiring. The Electric Controller & Mfg. Co., 2700 E. 79th St., Cleveland, Ohio.

Steel Doors

Tubular steel doors, known as the "Float-Over" line. Made in three types —flush, standard, and molded panel. Doors are built on frames of 2-in., cold-rolled, galvanized, copper-bearing steel tubes, and operate upward on two cold-rolled steel tracks. The doors ride at all points on ball bearings. Cables winding on machine-grooved drums lift and lower the doors. A counterbalance makes lifting easier. Cornell Iron Works, Long Island City, N. Y.

TRADE LITERATURE

LININGS—Booklet, eight pages, "Goodrich Triflex Linings in Steel Pickling Tanks."—The B. F. Goodrich Rubber Co., Akron, Ohio.

VARIABLE SPEED TRANSMISSION—Folder F777, four pages, "Varidrive" motor for speeds from 25 to 10,000 r.p.m.—U. S. Electrical Mfg. Co., Los Angeles, Calif.

WELDERS—Leaflet, applications and distinctive features of the new 300-amp. Flex-Arc welders, designed especially to handle a current range from 90 to 375 amp.—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

STAINLESS STEEL—Form 217, 14 pages, information on architectural applications of Enduro stainless steel, its fabrication, properties, shapes, and finishes available.—Republic Steel Corp., Republic Building, Youngstown, Ohio.

MACHINING — Bulletin 166, 25 pages, Centrode Device.—The Monarch Machine Tool Co., Sidney, Ohio.

MOTORS—Bulletin 2320, low-speed synchronous motors—continuous-duty, high- and low-voltage, engine types, and pedestal-bearing types for coupled and belted service.—Fairbanks-Morse & Co., Chicago, Ill.

INDUSTRIAL ENGINEERING—Bulletin, 48 pages, principles of industrial plant engineering, a layman's glance of papermaking, and joint firm power plants.—V. D. Simons, Inc., 435 N. Michigan Ave., Chicago, Ill.

CIRCUIT BREAKERS—Folder GEA-1014A, type MR, circuit breakers for 600-volt railway service.—General Electric Co., Schenectady, N. Y.

WROUGHT IRON—Form 1521, wrought iron forging billets.—A. M. Byers Co., Pittsburgh, Pa.

PUMPS — Bulletin D-412-V2, forged, fluid-end, high-pressure power pumps.—Worthington Pump & Machinery Corp., Worthington Ave. at Warren St., Harrison, N. J.

REDUCTION UNITS—Bulletin 1164, four pages, self-contained motor reduction units.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

ELECTRIC FURNACES—Bulletin 280, eight pages, "Falcon" electric furnaces for hardening, tempering and annealing strip metal and wire products.—H. O. Swoboda, Inc., 3530 Forbes St., Pittsburgh., Pa.

RUBBER GOODS—Bulletin, 24 pages, "A Buyer's Guide to Mechanical Rubber Goods." — Diamond Rubber Co., Inc., Akron, Ohio.

MATERIALS HANDLING — Form 636, 12 pages, "By Skidplate and Bumper to Lower Costs," the story of a one-man materials delivery system.—The Cleveland Tractor Co., Cleveland, Ohio.

LININGS—Bulletin 1, six pages, "Acid, Alkali and Corrosion-Resisting Linings for Industrial Equipment."—Stebbins Engineering & Mfg. Co., Watertown, N. Y.

CARBOLOY TOOLS — Bulletin, 16 pages, complete instructions for a simplified method of manufacturing Carboloy tools.—Carboloy Co., Inc., Detroit, Mich.